TableNet: Deep Learning model for end-to-end Table detection and Tabular data extraction from Scanned Document Images

In [1]:

```
from google.colab import drive
drive.mount('/content/drive')
```

```
Mounted at /content/drive
```

ABSTRACT

With the widespread use of mobile phones and scanners to photograph and upload documents, the need for extracting the information trapped in unstructured document images such as retail receipts, insurance claim forms and financial invoices is becoming more acute. A major hurdle to this objective is that these images often contain information in the form of tables and extracting data from tabular sub-images presents a unique set of challenges. This includes accurate detection of the tabular region within an image, and subsequently detecting and extracting information from the rows and columns of the detected table.

A reasearch paper where model is proposed as TableNet: a novel end-toend deep learning model for both table detection and structure recognition. The model exploits the interdependence between the twin tasks of table detection and table structure recognition to segment out the table and column regions. This is followed by semantic rule-based row extraction from the identified tabular sub-regions.

Problem Statement

From a given scanned document image,we have to locate the table and identify its internal structure.After Table and its structure is idetified,information has to be extracted from the table.

1.3 Real world Objectives and constraints

Objectives:

1. Predict the loation of a bale and its structure and extract its information
2. Minimize the difference between predicted and actual table detection.

Constraints:

1. Some form of interpretability.

2. Machine Learning Problem

About Marmot dataset

This reserach paper is trained on Marmot table dataset which is annotated by the research team.This is the largest publicly available dataset for table detection.

This annotated dataset consists of 502 scanned images and their corresponding annotation files.Each Annotatin file is a xml file which gives the coordinates of the table and its columns in the images.It is the groud truth for the table detection.

For creating model with this data,we have to get the coordinates of the tables from the xml files and then train on the images

2.2 Mapping the real world problem to a Machine Learning Problem

2.2.1 Type of Machine Learning Problem

```
For a given document image we have to do semantic segmentation by classyfying ea
ch pixel as a table or not.It is deep learning smenatic segmentatin problem.
```

2.2.2 Performance metric

```
As this is a classification problem following metrics will help in better predic
tion.
```

- F1 Score: This metric tries to create a balance between precision and recall.Here we are interested in more numbers of correct predictions.
- Precision
- Recall

In [ ]:

```
import keras
#from keras.datasets import mnist
from keras.models import Sequential
from keras.layers import Dense, Dropout, Flatten,Input
from keras.layers import Conv2D, MaxPooling2D, Conv2DTranspose
from keras.applications.vgg19 import VGG19
from keras import layers
```

In [26]:

```
import xml.etree.ElementTree as et
import os
import numpy as np
from PIL import Image
```

EDA & Generation of the Data

In [1]:

```
data_directory='/content/drive/MyDrive/tablenet_colab/marmot_image2/'
```

In [2]:

```
col_mask_directory="/content/drive/MyDrive/tablenet_colab/col_mask/"
```

In [3]:

```
tbl_mask_directory="/content/drive/MyDrive/tablenet_colab/tbl_mask/"
```

In [4]:

```
jpg_img_directory="/content/drive/MyDrive/tablenet_colab/jpgimg/"
```

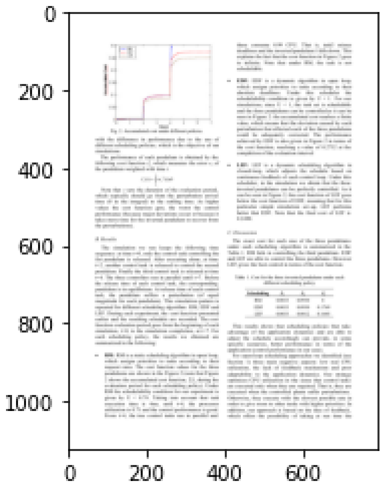
In [ ]:

```
#Display of scanned images
from matplotlib.pyplot import imshow
import numpy as np
from PIL import Image
%matplotlib inline

flst=os.listdir(data_directory)

pil_im = Image.open(data_directory+flst[0])
print(flst[0])
imshow(np.asarray(pil_im))
```

```
10.1.1.1.2006_3.bmp
```

Out[ ]:

```
<matplotlib.image.AxesImage at 0x23fe2cf63d0>
```



- All the images are in bmp format and contains at least one table.
- Col mask and table mask have to saved for each image for training purpose.

In [ ]:

```python
import lxml.etree as etree

x = etree.parse(data_directory+flst[1])
print(etree.tostring(x, pretty_print=True,encoding="unicode"))
```

```
<annotation verified="yes">
        <folder>MARMOT_ANNOTATION</folder>
        <filename>10.1.1.1.2006_3.bmp</filename>
        <path>/home/monika/Desktop/MARMOT_ANNOTATION/10.1.1.1.2006_3.bmp</
path>
        <source>
                <database>Unknown</database>
        </source>
        <size>
                <width>793</width>
                <height>1123</height>
                <depth>3</depth>
        </size>
        <segmented>0</segmented>
        <object>
                <name>column</name>
                <pose>Unspecified</pose>
                <truncated>0</truncated>
                <difficult>0</difficult>
                <bndbox>
                        <xmin>458</xmin>
                        <ymin>710</ymin>
                        <xmax>517</xmax>
                        <ymax>785</ymax>
                </bndbox>
        </object>
        <object>
                <name>column</name>
                <pose>Unspecified</pose>
                <truncated>0</truncated>
                <difficult>0</difficult>
                <bndbox>
                        <xmin>531</xmin>
                        <ymin>710</ymin>
                        <xmax>568</xmax>
                        <ymax>783</ymax>
                </bndbox>
        </object>
        <object>
                <name>column</name>
                <pose>Unspecified</pose>
                <truncated>0</truncated>
                <difficult>0</difficult>
                <bndbox>
                        <xmin>583</xmin>
                        <ymin>712</ymin>
                        <xmax>619</xmax>
                        <ymax>785</ymax>
                </bndbox>
        </object>
        <object>
                <name>column</name>
                <pose>Unspecified</pose>
                <truncated>0</truncated>
                <difficult>0</difficult>
                <bndbox>
                        <xmin>637</xmin>
                        <ymin>712</ymin>
                        <xmax>670</xmax>
                        <ymax>784</ymax>
                </bndbox>
        </object>
</annotation>
```

- Each xml file contains the coordinates for the columns of the table.
- Each xml fie has to be parsed to get the table and column cordinates and create the corresponding column and table masks from the image.
- Column and table masks are basically images where column & table fields have white pixel and rest of the image is black.
- These masks will serve as ground truth for training on original image.

In [ ]:

```
def sameTable(ymin_1, ymin_2, ymax_1, ymax_2):
    min_diff = abs(ymin_1 - ymin_2)
    max_diff = abs(ymax_1 - ymax_2)

    if min_diff <= 5 and max_diff <=5:
        return True
    elif min_diff <= 4 and max_diff <=7:
        return True
    elif min_diff <= 7 and max_diff <=4:
        return True
    return False
```

In [ ]:

```
for file in os.listdir(data_directory):
    if ".xml" in file:
        filename=file[:-4]
        tree = et.parse(data_directory+file)
        root = tree.getroot()
        size = root.find('size')
        width = int(size.find('width').text)
        height = int(size.find('height').text)


        col_mask = np.zeros((height, width), dtype=np.int32)
        table_mask = np.zeros((height, width), dtype = np.int32)
        got_first_column = False
        i=0
        table_xmin = 10000
        table_xmax = 0

        table_ymin = 10000
        table_ymax = 0

        for column in root.findall('object'):

            bndbox = column.find('bndbox')
            xmin = int(bndbox.find('xmin').text)
            ymin = int(bndbox.find('ymin').text)
            xmax = int(bndbox.find('xmax').text)
            ymax = int(bndbox.find('ymax').text)

            col_mask[ymin:ymax, xmin:xmax] = 255

            if got_first_column:
                if sameTable(prev_ymin, ymin, prev_ymax, ymax) == False:

                    i+=1
                    got_first_column = False
                    table_mask[table_ymin:table_ymax, table_xmin:table_xmax] = 255

                    table_xmin = 10000
                    table_xmax = 0

                    table_ymin = 10000
                    table_ymax = 0

            if got_first_column == False:

                got_first_column = True
                first_xmin = xmin

            prev_ymin = ymin
            prev_ymax = ymax

            table_xmin = min(xmin, table_xmin)
            table_xmax = max(xmax, table_xmax)

            table_ymin = min(ymin, table_ymin)
            table_ymax = max(ymax, table_ymax)

        table_mask[table_ymin:table_ymax, table_xmin:table_xmax] = 255
        im = Image.fromarray(col_mask.astype(np.uint8),'L')
        im.save(col_mask_directory + filename + ".jpeg")

        im = Image.fromarray(table_mask.astype(np.uint8),'L')
        im.save(tbl_mask_directory + filename + ".jpeg")
```

In [ ]:

```
for file in os.listdir(data_directory):
    if ".bmp" in file:
        filename=file[:-4]
        pil_im = Image.open(data_directory+file)
        #im = Image.fromarray(np.asarray(pil_im))
        pil_im.save(jpg_img_directory + filename + ".jpeg")
```

In [ ]:

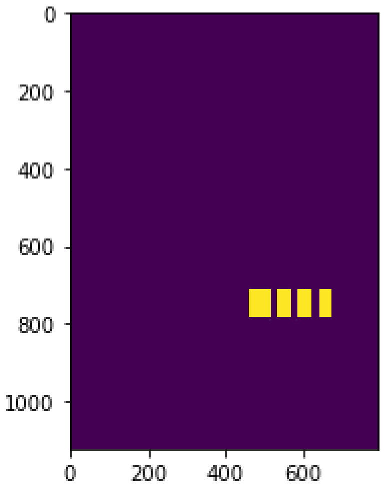
```
# Sample Column mask
flst=os.listdir(col_mask_directory)

pil_im = Image.open(col_mask_directory+flst[0])
print(flst[0])
imshow(np.asarray(pil_im))
```

```
10.1.1.1.2006_3.jpeg
```

Out[ ]:

```
<matplotlib.image.AxesImage at 0x1c0c5fa1a60>
```



In [ ]:

```
flst="/content/drive/MyDrive/tablenet_colab/col_mask/10.1.1.1.2006_3.jpeg"

pil_im = tf.io.read_file(flst)
# print(flst[0])
# imshow(np.asarray(pil_im))
#il_im.mode
#image=pil_im.resize([1024, 1024])
img = tf.image.decode_jpeg(pil_im,channels=3)
img=tf.image.resize(img, [1024, 1024])
img=tf.cast(img, tf.float32) / 255.0
```

In [ ]:

```
img.shape
```

Out[ ]:

```
TensorShape([1024, 1024, 3])
```

In [ ]:

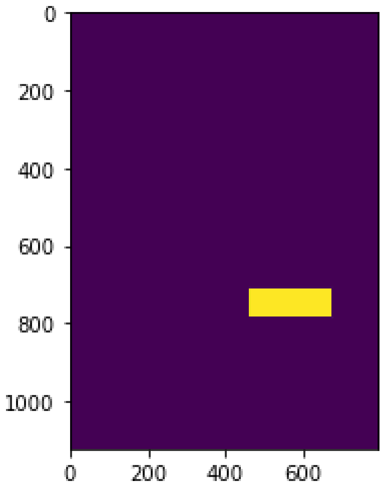
```
# Sample Table mask
flst=os.listdir(tbl_mask_directory)

pil_im = Image.open(tbl_mask_directory+flst[0])
print(flst[0])
imshow(np.asarray(pil_im))
```

```
10.1.1.1.2006_3.jpeg
```

Out[ ]:

```
<matplotlib.image.AxesImage at 0x1c0c6727760>
```



Model

In [5]:

```
import tensorflow as tf
import matplotlib.pyplot as plt
import numpy as np
from tensorflow.keras import Sequential
from tensorflow.keras.models import Model
from tensorflow.keras.layers import BatchNormalization
from tensorflow.keras.layers import Conv2D
from tensorflow.keras.layers import MaxPooling2D
from tensorflow.keras.layers import Activation
from tensorflow.keras.layers import Dropout
from tensorflow.keras.layers import Lambda
from tensorflow.keras.layers import Dense
from tensorflow.keras.layers import Flatten
from tensorflow.keras.layers import Input, Concatenate, UpSampling2D
from tensorflow.keras.callbacks import TensorBoard
from tensorflow.keras.callbacks import ModelCheckpoint,TensorBoard,ReduceLROnPlateau, EarlyStopping
from tensorflow.keras import backend as K
```

In [6]:

```
img_height, img_width = 1024, 1024

def normalize(input_image):
    input_image = tf.cast(input_image, tf.float32) / 255.0
    return input_image

def decode_img(img):

  # convert the compressed string to a 3D uint8 tensor
    img = tf.image.decode_jpeg(img, channels=3)
  # resize the image to the desired size
    #image=tf.image.resize(image, [1024, 1024])
    img=tf.image.resize(img, [img_height, img_width])
    #img = np.reshape(img,[1,img_height, img_width,3])
    return img

def decode_mask_img(img):
  # convert the compressed string to a 2D uint8 tensor
    img = tf.image.decode_jpeg(img, channels=1)
  # resize the image to the desired size
    img=tf.image.resize(img, [img_height, img_width])
    #img = np.reshape(img,[1,img_height, img_width,3])
    return img

def process_path(file_path):

    file_path = tf.strings.regex_replace(file_path, '.xml', '.bmp')
    img_file_path = tf.strings.regex_replace(file_path, 'marmot_image2', 'jpgimg')
    img_file_path2 = tf.strings.regex_replace(img_file_path, '.bmp', '.jpeg')
    mask_file_path = tf.strings.regex_replace(file_path, '.bmp', '.jpeg')
    table_mask_file_path = tf.strings.regex_replace(mask_file_path, 'marmot_image2', 't
bl_mask')
    column_mask_file_path = tf.strings.regex_replace(mask_file_path, 'marmot_image2',
'col_mask')
    img = normalize(decode_img(tf.io.read_file(img_file_path2)))
    print(img.shape)
    table_mask = decode_mask_img(tf.io.read_file(table_mask_file_path))/255.0
    column_mask = decode_mask_img(tf.io.read_file(column_mask_file_path))/255.0
    return img, {"table_output" : table_mask, "column_output" : column_mask }
```

In [7]:

```
xml_dataset = tf.data.Dataset.list_files('/content/drive/MyDrive/tablenet_colab/marmot_
image2/*.xml')
#BUFFER_SIZE = 502
#full_dataset = xml_dataset.shuffle(BUFFER_SIZE)
```

In [8]:

```
len(list(xml_dataset))
```

Out[8]:

```
494
```

In [9]:

```
train_size = 395
test_size = 99

# full_dataset = tf.data.TFRecordDataset(FLAGS.input_file)
# full_dataset = full_dataset.shuffle()
train_dataset = xml_dataset.take(train_size)
test_dataset = xml_dataset.skip(train_size)
#val_dataset = test_dataset.take(val_size)
#test_dataset = test_dataset.skip(val_size)
```

In [10]:

```
BATCH_SIZE = 2
TRAIN_LENGTH=len(list(train_dataset))
STEPS_PER_EPOCH = TRAIN_LENGTH // BATCH_SIZE
BUFFER_SIZE=494

#train_dataset = train_dataset.shuffle(BUFFER_SIZE)
#val_dataset = val_dataset.shuffle(BUFFER_SIZE)


train_dataset = train_dataset.map(process_path)
#val_dataset = val_dataset.map(process_path)
train_dataset = train_dataset.shuffle(BUFFER_SIZE)
test_dataset = test_dataset.map(process_path)

train_dataset1 = train_dataset.batch(BATCH_SIZE).repeat()
train_dataset1 = train_dataset1.prefetch(buffer_size=tf.data.experimental.AUTOTUNE)
#val_dataset1 = val_dataset.batch(BATCH_SIZE,drop_remainder=True).repeat().prefetch(buf
fer_size=tf.data.experimental.AUTOTUNE)
test_dataset1 = test_dataset.batch(BATCH_SIZE)
```

```
(1024, 1024, 3)
(1024, 1024, 3)
```

In [11]:

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

  title = ['Input Image', 'Table Mask', 'Column Mask','mod image']

  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()
```

In [13]:

```
for a,b in train_dataset.take(2):
    print(a.shape)
    #display([a, b['table_output'], b['column_output']])
```

```
(256, 256, 3)
(256, 256, 3)
```

In [12]:

```
class TableNet:
    @staticmethod

    def build_table_decoder(inputs, pool3, pool4):
        #x1=UpSampling2D(size=(2, 2),interpolation='bilinear')(pool4)
        x2=tf.keras.layers.MaxPooling2D(
    pool_size=(2, 2), strides=None, padding="valid", data_format=None)(pool3)
        x = Conv2D(512, (1, 1), activation = 'relu', name='conv7_table')(inputs)
        x = UpSampling2D(size=(2, 2),interpolation='bilinear')(x)
        # x = Conv2D(512, (1, 1), activation = 'relu', name='conv8_table')(x)
        # x = Dropout(0.8, name='block8_dropout_column')(x)

        concatenated = Concatenate()([x, pool4])

        x = UpSampling2D(size=(2,2),interpolation='bilinear')(concatenated)
        concatenated = Concatenate()([x, x2])

        x = UpSampling2D(size=(2,2),interpolation='bilinear')(concatenated)
        x = UpSampling2D(size=(2,2),interpolation='bilinear')(x)
        last = tf.keras.layers.Conv2DTranspose(
      2, 3, strides=2,
        padding='same', name='table_output',activation='softmax')
        #x = last2(x)
        x = last(x)
        return x

    @staticmethod
    def build_column_decoder(inputs, pool3, pool4):
        x2=tf.keras.layers.MaxPooling2D(
          pool_size=(2, 2), strides=None, padding="valid", data_format=None)(pool3)
        x = Conv2D(512, (1, 1), activation = 'relu', name='block7_conv1_column')(inputs
)
        x = Dropout(0.8, name='block7_dropout_column')(x)

        x = Conv2D(512, (1, 1), activation = 'relu', name='block8_conv1_column')(x)
        x = UpSampling2D(size=(2, 2),interpolation='bilinear')(x)

        concatenated = Concatenate()([x, pool4])

        x = UpSampling2D(size=(2,2),interpolation='bilinear')(concatenated)
        concatenated = Concatenate()([x, x2])
        x = UpSampling2D(size=(2,2),interpolation='bilinear')(concatenated)
        x = UpSampling2D(size=(2,2),interpolation='bilinear')(x)
        last = tf.keras.layers.Conv2DTranspose(
      2, 3, strides=2,
        padding='same', name='column_output',activation='softmax')
        #x = last2(x)
        x = last(x)

        return x

    @staticmethod
    def vgg_base(inputs):
        base_model = tf.keras.applications.DenseNet121(
        input_shape=[1024, 1024, 3],
        include_top=False, weights='imagenet',classes=1000)

        layer_names = ['conv2_block6_concat', 'conv4_block9_0_relu', 'conv5_block1_0_re
lu']
```

```
        layers = [base_model.get_layer(name).output for name in layer_names]

        pool_layers_model = Model(inputs=base_model.input, outputs=layers, name='Densenet')
        pool_layers_model.trainable = False

        return pool_layers_model(inputs)

    @staticmethod
    def build():
        inputShape = (1024, 1024, 3)

        inputs = Input(shape=inputShape, name='input')

        pool_layers = TableNet.vgg_base(inputs)

        x = Conv2D(512, (1, 1), activation = 'relu', name='block6_conv1')(pool_layers[2])
        x = Dropout(0.8, name='block6_dropout1')(x)
        x = Conv2D(512, (1, 1), activation = 'relu', name='block6_conv2')(x)
        x = Dropout(0.8, name = 'block6_dropout2')(x)

        table_mask = TableNet.build_table_decoder(x, pool_layers[0], pool_layers[1])
        column_mask = TableNet.build_column_decoder(x, pool_layers[0], pool_layers[1])

        model = Model(
              inputs=inputs,
                                outputs=[table_mask, column_mask],
                                name="tablenet")

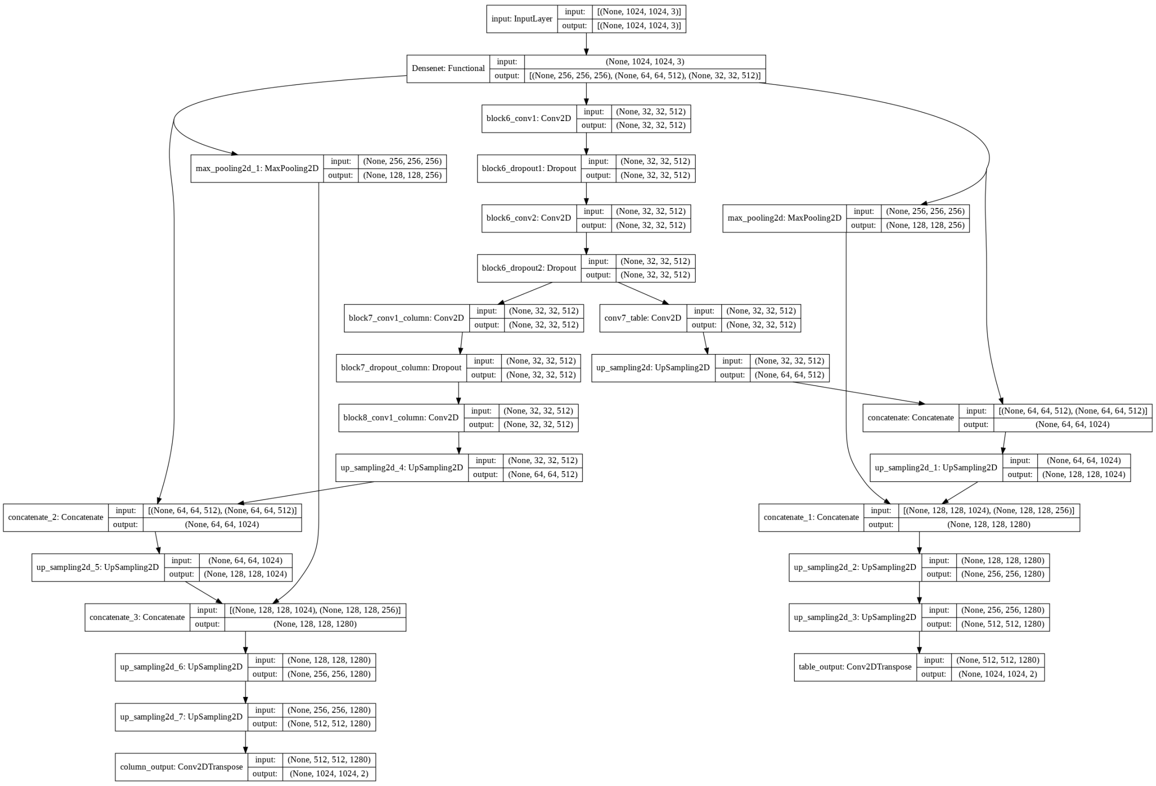
        return model
```

In [13]:

In [13]:

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

Out[13]:


input: InputLayer | input: | [(None, 1024, 1024, 3)] | output: | [(None, 1024, 1024, 3)]
Densenet: Functional | input: | (None, 1024, 1024, 3) | output: | [(None, 256, 256, 256), (None, 64, 64, 512), (None, 32, 32, 512)]
block6_conv1: Conv2D | input: | (None, 32, 32, 512) | output: | (None, 32, 32, 512)
max_pooling2d_1: MaxPooling2D | input: | (None, 256, 256, 256) | output: | (None, 128, 128, 256)
block6_dropout1: Dropout | input: | (None, 32, 32, 512) | output: | (None, 32, 32, 512)
block6_conv2: Conv2D | input: | (None, 32, 32, 512) | output: | (None, 32, 32, 512)
max_pooling2d: MaxPooling2D | input: | (None, 256, 256, 256) | output: | (None, 128, 128, 256)
block6_dropout2: Dropout | input: | (None, 32, 32, 512) | output: | (None, 32, 32, 512)
block7_conv1_column: Conv2D | input: | (None, 32, 32, 512) | output: | (None, 32, 32, 512)
conv7_table: Conv2D | input: | (None, 32, 32, 512) | output: | (None, 32, 32, 512)
block7_dropout_column: Dropout | input: | (None, 32, 32, 512) | output: | (None, 32, 32, 512)
up_sampling2d: UpSampling2D | input: | (None, 32, 32, 512) | output: | (None, 64, 64, 512)
block8_conv1_column: Conv2D | input: | (None, 32, 32, 512) | output: | (None, 32, 32, 512)
concatenate: Concatenate | input: | [(None, 64, 64, 512), (None, 64, 64, 512)] | output: | (None, 64, 64, 1024)
up_sampling2d_4: UpSampling2D | input: | (None, 32, 32, 512) | output: | (None, 64, 64, 512)
up_sampling2d_1: UpSampling2D | input: | (None, 64, 64, 1024) | output: | (None, 128, 128, 1024)
concatenate_2: Concatenate | input: | [(None, 64, 64, 512), (None, 64, 64, 512)] | output: | (None, 64, 64, 1024)
concatenate_1: Concatenate | input: | [(None, 128, 128, 1024), (None, 128, 128, 256)] | output: | (None, 128, 128, 1280)
up_sampling2d_5: UpSampling2D | input: | (None, 64, 64, 1024) | output: | (None, 128, 128, 1024)
up_sampling2d_2: UpSampling2D | input: | (None, 128, 128, 1280) | output: | (None, 256, 256, 1280)
concatenate_3: Concatenate | input: | [(None, 128, 128, 1024), (None, 128, 128, 256)] | output: | (None, 128, 128, 1280)
up_sampling2d_3: UpSampling2D | input: | (None, 256, 256, 1280) | output: | (None, 512, 512, 1280)
up_sampling2d_6: UpSampling2D | input: | (None, 128, 128, 1280) | output: | (None, 256, 256, 1280)
table_output: Conv2DTranspose | input: | (None, 512, 512, 1280) | output: | (None, 1024, 1024, 2)
up_sampling2d_7: UpSampling2D | input: | (None, 256, 256, 1280) | output: | (None, 512, 512, 1280)
column_output: Conv2DTranspose | input: | (None, 512, 512, 1280) | output: | (None, 1024, 1024, 2)

In [14]:

```
class F1_Score(tf.keras.metrics.Metric):

    def __init__(self, name='f1_score', **kwargs):
        super().__init__(name=name, **kwargs)
        self.f1 = self.add_weight(name='f1', initializer='zeros')
        self.precision_fn = tf.keras.metrics.Precision(thresholds=0.5)
        self.recall_fn = tf.keras.metrics.Recall(thresholds=0.5)
        #self.f1_list=[]

    def update_state(self, y_true, y_pred, sample_weight=None):
        # y_pred=tf.argmax(y_pred, axis=-1)
        # y_pred=tf.argmax(y_pred, axis=-1)
        p = self.precision_fn(y_true,tf.argmax(y_pred, axis=-1) )
        r = self.recall_fn(y_true, tf.argmax(y_pred, axis=-1))
        # since f1 is a variable, we use assign
        self.f1.assign(2 * ((p * r) / (p + r + 1e-6)))
        #self.f1_list.append(self.f1.assign(2 * ((p * r) / (p + r + 1e-6))))

    def result(self):
        return self.f1

    def reset_states(self):
        # we also need to reset the state of the precision and recall objects
        self.precision_fn.reset_states()
        self.recall_fn.reset_states()
        self.f1.assign(0)
```

In [15]:

```
def create_mask(pred_mask1, pred_mask2):
  pred_mask1 = tf.argmax(pred_mask1, axis=-1)
  pred_mask1 = pred_mask1[..., tf.newaxis]


  pred_mask2 = tf.argmax(pred_mask2, axis=-1)
  pred_mask2 = pred_mask2[..., tf.newaxis]
  return pred_mask1[0], pred_mask2[0]
```

In [16]:

```
def show_predictions(dataset=None, num=1):
  if dataset:
    for image, (mask1, mask2) in dataset.take(num):
      pred_mask1, pred_mask2 = model.predict(image, verbose=1)
      table_mask, column_mask = create_mask(pred_mask1, pred_mask2)

      display([image[0], table_mask, column_mask])
  else:
    pred_mask1, pred_mask2 = model.predict(sample_image, verbose=1)
    table_mask, column_mask = create_mask(pred_mask1, pred_mask2)

    display([sample_image[0], table_mask, column_mask])
```

In [17]:

```
for image, mask in train_dataset1.take(1):
  sample_image, sample_mask1, sample_mask2 = image, mask['table_output'], mask['column_
output']

from IPython.display import clear_output

class DisplayCallback(tf.keras.callbacks.Callback):
  def __init__(self):
        self.history = {'table_output_loss':[]}
        self.init_lr = init_lr
  def on_epoch_end(self, epoch, logs=None):
    clear_output(wait=True)
    #show_predictions()
    #print ('\nSample Prediction after epoch {}\n'.format(epoch+1))
    if epoch % 1 == 0:
            show_predictions(test_dataset1, 1)


            self.history['table_output_loss'].append(logs.get('table_output_loss'))
            if epoch > 2:
                cur_loss = self.history['table_output_loss'][epoch]
                prev_loss = self.history['table_output_loss'][epoch-1]

                if cur_loss > prev_loss:
                    self.init_lr = self.init_lr * 0.93
                    K.set_value(self.model.optimizer.learning_rate, self.init_lr)
```

In [18]:

```
losses = {
        "table_output": tf.keras.losses.SparseCategoricalCrossentropy(from_logits=False
),
  "column_output": tf.keras.losses.SparseCategoricalCrossentropy(from_logits=False),
}

lossWeights = {"table_output": 1.0, "column_output": 1.0}



#filepath = "model checkpoint/table_net.h5"
checkpoint1 = ModelCheckpoint("model_1.h5",
                             monitor="val_loss",
                             mode="min",
                             save_best_only = True,
                             verbose=1)
earlystop1 = EarlyStopping(monitor = 'val_loss',
                            mode="min",
                            min_delta = 0,
                            patience = 5,
                            verbose = 1)
tensorboard1 = TensorBoard(log_dir='Model1_visualization')
metrics1 = F1_Score()
global init_lr
init_lr = 0.0001
model.compile(optimizer=tf.keras.optimizers.Adam(learning_rate=init_lr, epsilon=1e-08),
              loss=losses,
              metrics=[metrics1],
              loss_weights=lossWeights)
```

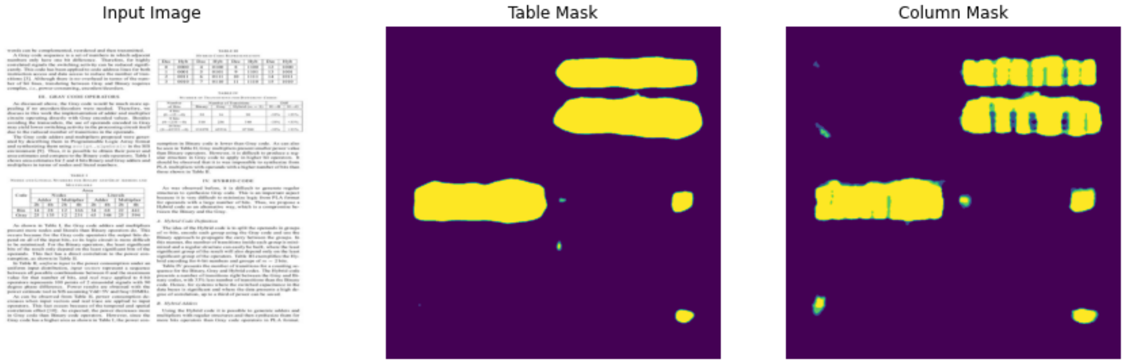
In [20]:

```
```

In [19]:

```
EPOCHS = 50
VAL_SUBSPLITS = 5
VALIDATION_STEPS = 99//BATCH_SIZE//VAL_SUBSPLITS
train_steps=train_steps = train_size // BATCH_SIZE
history = model.fit(train_dataset1,
                              epochs=EPOCHS,
                              steps_per_epoch=train_steps,
                              validation_data=test_dataset1,
                              validation_steps=VALIDATION_STEPS,
                               callbacks=[checkpoint1,tensorboard1,earlystop1,DisplayCa
llback()])
#callbacks=[checkpoint1,earlystop1,tensorboard1]
```

```
1/1 [==============================] - 0s 133ms/step
```

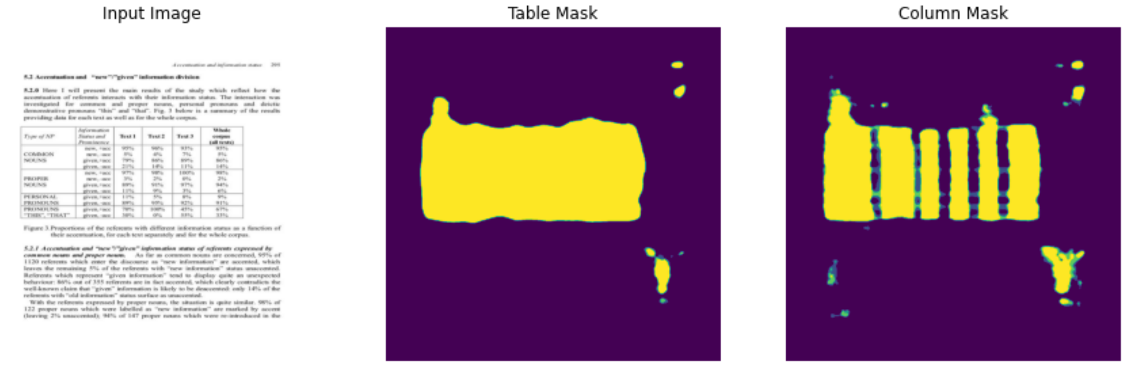


```
Epoch 00010: early stopping
```

In [20]:

```
show_predictions()
```

```
1/1 [==============================] - 0s 56ms/step
```

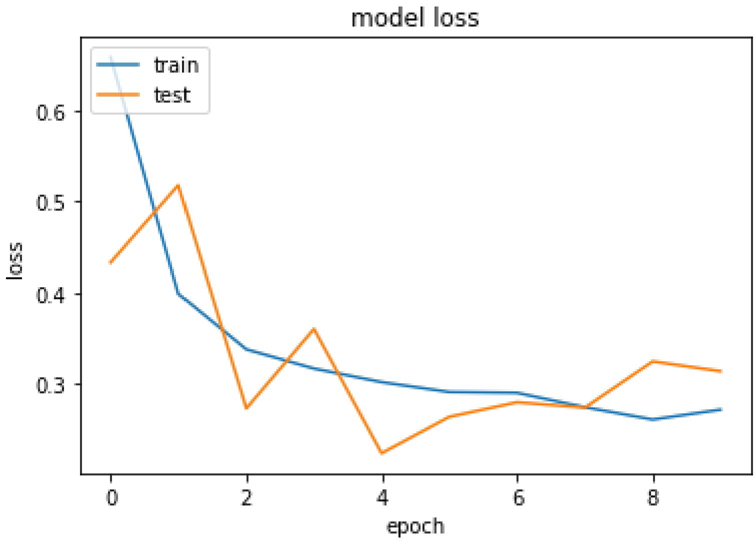


In [21]:

```
model.save("/content/drive/MyDrive/tablenet_colab/tablenet.h5")
```

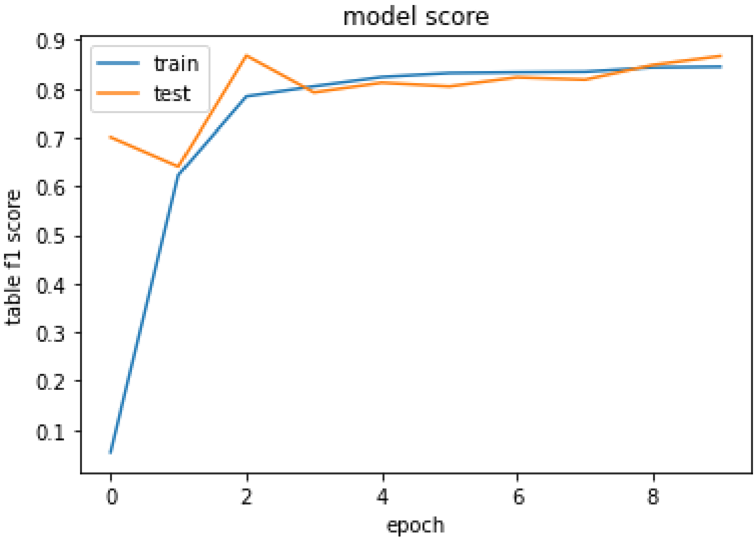
In [22]:

```
plt.plot(history.history['loss'])
plt.plot(history.history['val_loss'])
plt.title('model loss')
plt.ylabel('loss')
plt.xlabel('epoch')
plt.legend(['train', 'test'], loc='upper left')
plt.show()
```



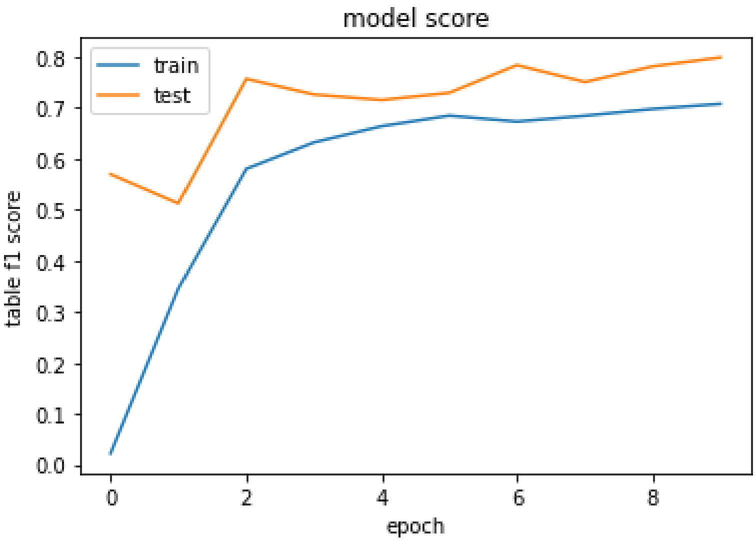
In [23]:

```
plt.plot(history.history['table_output_f1_score'])
plt.plot(history.history['val_table_output_f1_score'])
plt.title('model score')
plt.ylabel('table f1 score')
plt.xlabel('epoch')
plt.legend(['train', 'test'], loc='upper left')
plt.show()
```



In [24]:

```
plt.plot(history.history['column_output_f1_score'])
plt.plot(history.history['val_column_output_f1_score'])
plt.title('model score')
plt.ylabel('table f1 score')
plt.xlabel('epoch')
plt.legend(['train', 'test'], loc='upper left')
plt.show()
```



Predictions

In [15]:

```
model_path = "/content/drive/MyDrive/tablenet_colab/tablenet.h5"
model.load_weights(model_path)
```

In [38]:

```
import pytesseract
from io import StringIO
count = 0
text1=""
for image, mask in test_dataset1.take(5):


    print(image.shape)

    table_mask_pred, col_mask_pred = model.predict(image)

    table_mask_pred = tf.argmax(table_mask_pred, axis=-1)
    table_mask_pred = table_mask_pred[..., tf.newaxis][0]

    col_mask_pred = tf.argmax(col_mask_pred, axis=-1)
    col_mask_pred = col_mask_pred[..., tf.newaxis][0]

    im=tf.keras.preprocessing.image.array_to_img(image[0])
    im.save('image.png')

    im=tf.keras.preprocessing.image.array_to_img(table_mask_pred)
    im.save('table_mask_pred.png')

    im=tf.keras.preprocessing.image.array_to_img(col_mask_pred)
    im.save('col_mask_pred.png')



    img_org = Image.open('./image.png')
    table_mask = Image.open('./table_mask_pred.png')
    col_mask = Image.open('./col_mask_pred.png')


    # convert images
    img_mask = table_mask.convert('L')
    # img_mask = col_mask.convert('L')

    # grayscale
    # add alpha channel
    img_org.putalpha(img_mask)

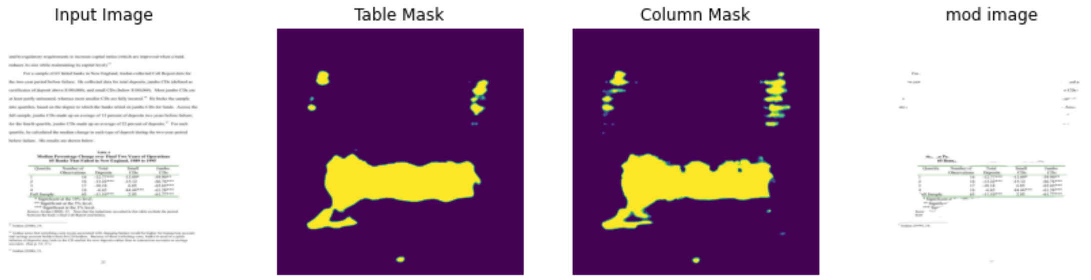
    # save as png which keeps alpha channel
    img_org.save('output.png')


    display([image[0], table_mask_pred, col_mask_pred, img_org])

    pytesseract.pytesseract.tesseract_cmd = (r'/usr/bin/tesseract')
    text = pytesseract.image_to_string(Image.open('/content/output.png'), lang='eng' )
# config='--psm 11'
    print(text)
    text1=text1+text
with open('csvfile.csv','w') as file:

    s = StringIO(text1)
    for line in s:
        file.write(line)
        file.write('\n')
```

```
(2, 1024, 1024, 3)
```



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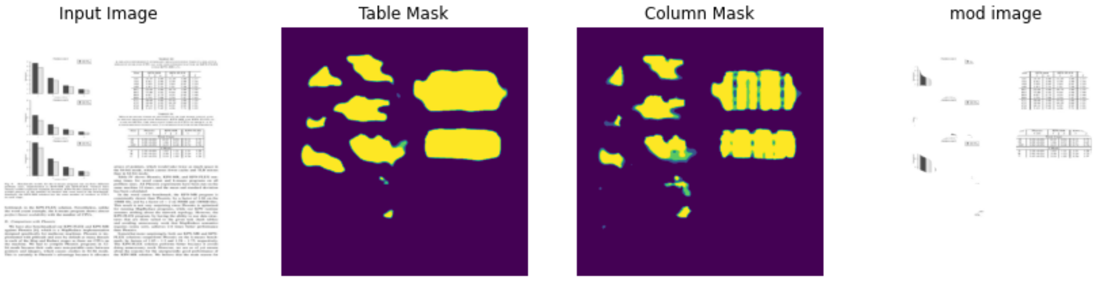

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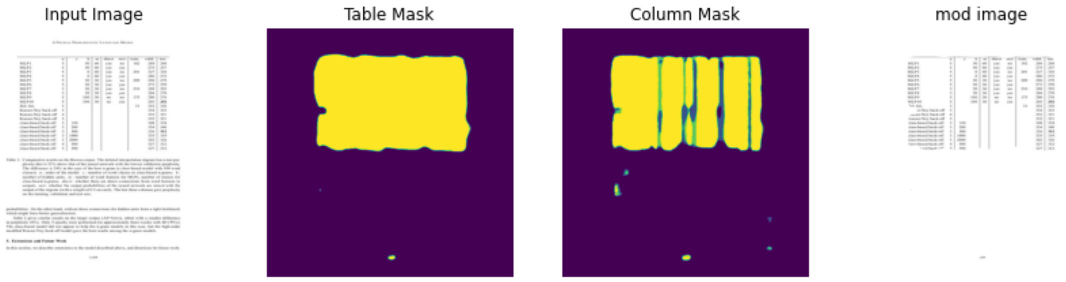

Input Image

Table Mask

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mod image

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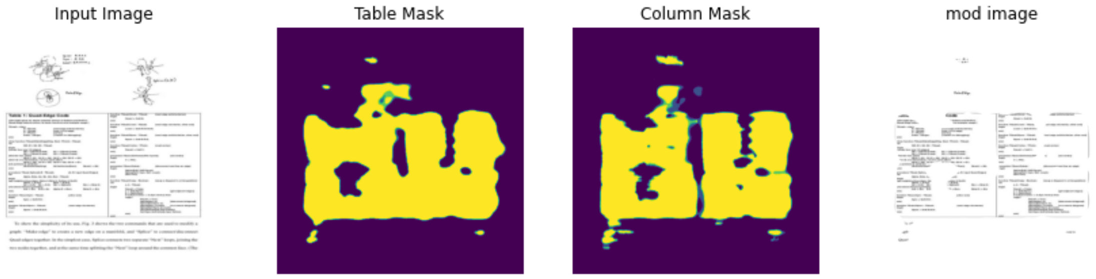

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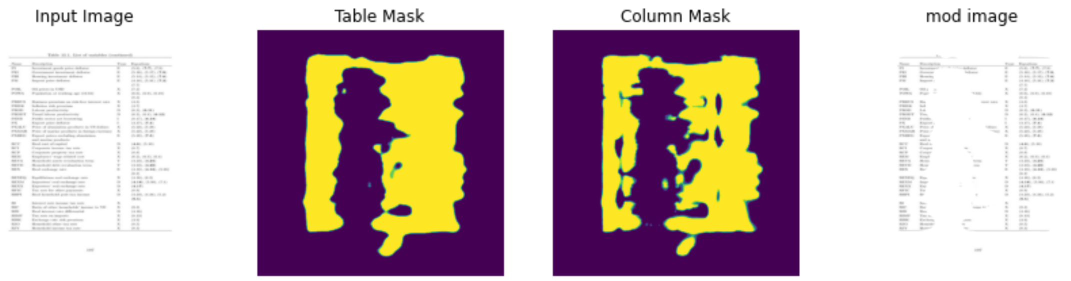

```
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In [ ]: