In [ ]:

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

```
Go to this URL in a browser: https://accounts.google.com/o/oauth2/auth?client_id=947318989803-6bn6qk8qdgf4n4g3pfee6491hc0brc4i.apps.google
usercontent.com&redirect_uri=urn%3aietf%3awg%3aoauth%3a2.0%3aoob&response_type=code&scope=email%20https%3a%2f%2fwww.googleapi
s.com%2fauth%2fdocs.test%20https%3a%2f%2fwww.googleapis.com%2fauth%2fdrive%20https%3a%2f%2fwww.googleapis.com%2fauth%2fdrive.
photos.readonly%20https%3a%2f%2fwww.googleapis.com%2fauth%2fpeopleapi.readonly

Enter your authorization code:
··········
Mounted at /content/drive
```

In [ ]:

```
import math
from PIL import Image, ImageDraw
from PIL import ImagePath
import pandas as pd
import os
from os import path, listdir
from tqdm import tqdm
import json
import cv2
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
import urllib
```

```
/usr/local/lib/python3.6/dist-packages/statsmodels/tools/_testing.py:19: FutureWarning: pandas.util.testing is deprecated. Use the functions in the pub
lic API at pandas.testing instead.
  import pandas.util.testing as tm
```

In [ ]:

```
# https://drive.google.com/drive/folders/1bynkOIXCurhJ9_Y5Q14KWX5yDyCRkKfN

import zipfile
with zipfile.ZipFile('/content/drive/My Drive/Copy of data.zip','r') as f:
  # extract the files in root and not in content folder
  f.extractall('/')
```

1. You can download the data from this link, and extract it

2. All your data will be in the folder "data"

3. Inside the data you will be having two folders

```
|--- data
|-----| ---- images
|-----| ------|----- Scene 1
|-----| ------|--------| ----- Frame 1 (image 1)
|-----| ------|--------| ----- Frame 2 (image 2)
|-----| ------|--------| ----- ...
|-----| ------|----- Scene 2
|-----| ------|--------| ----- Frame 1 (image 1)
|-----| ------|--------| ----- Frame 2 (image 2)
|-----| ------|--------| ----- ...
|-----| ------|----- .....
|-----| ---- masks
|-----| ------|----- Scene 1
|-----| ------|--------| ----- json 1 (labeled objects in image 1)
|-----| ------|--------| ----- json 2 (labeled objects in image 1)
|-----| ------|--------| ----- ...
|-----| ------|----- Scene 2
|-----| ------|--------| ----- json 1 (labeled objects in image 1)
|-----| ------|--------| ----- json 2 (labeled objects in image 1)
|-----| ------|--------| ----- ...
```

|-----| ------|----- .....

Task 1: Preprocessing

1. Get all the file name and corresponding json files

In [ ]:

```
def return_file_names_df(root_dir):
    # write the code that will create a dataframe with two columns ['images', 'json']
    # the column 'image' will have path to images
    # the column 'json' will have path to json files

    # https://stackoverflow.com/a/36898903/10219869
    image = []
    path = root_dir+'images/'
    for i, j, k in os.walk(path):
      for m in k:
        image.append(os.path.join(i, m))

    json = []
    path = root_dir+'mask/'
    for i, j, k in os.walk(path):
      for m in k:
        json.append(os.path.join(i, m))

    data_df = pd.DataFrame()
    data_df['image'] = sorted(image)
    data_df['json'] = sorted(json)

    return data_df
```

In [ ]:

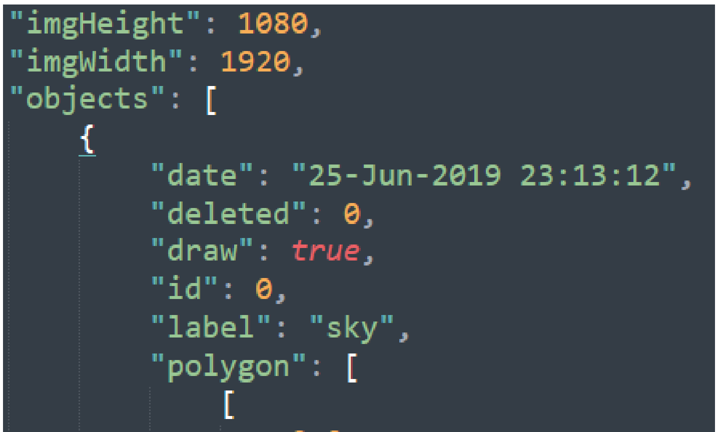
```
 # If you observe the dataframe, we can consider each row as single data point,
 # where first feature is image and the second feature is corresponding json file

root_dir = '/data/'

data_df = return_file_names_df(root_dir)
print(data_df.shape)
data_df.head()
```

```
(4008, 2)
```

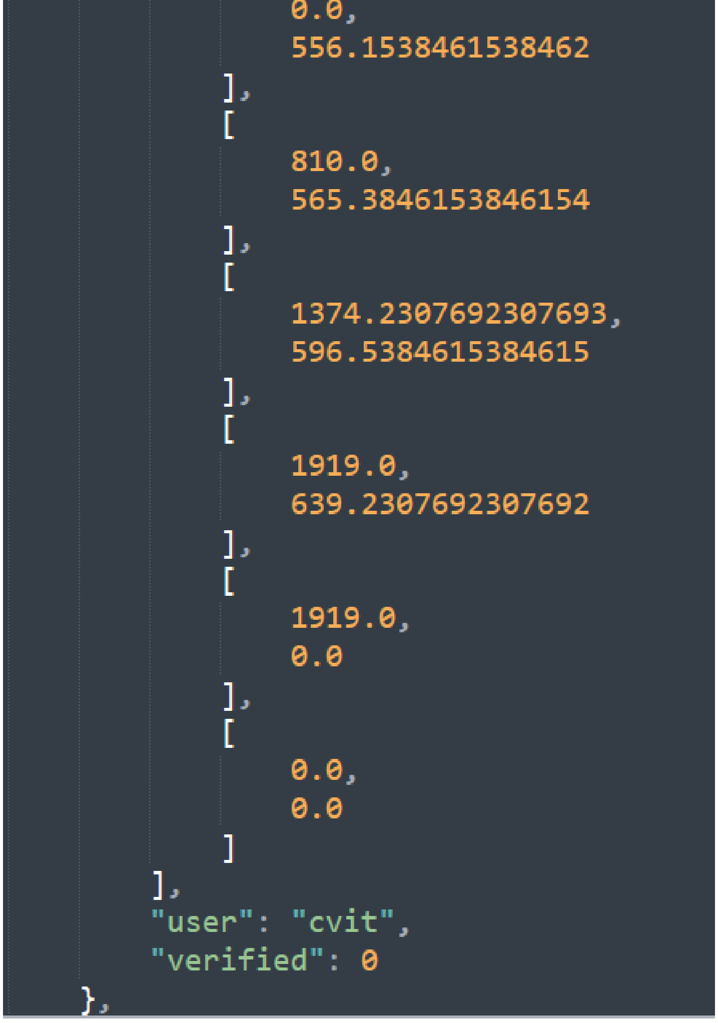
Out[ ]:

	image	json
0	/data/images/201/frame0029_leftImg8bit.jpg	/data/mask/201/frame0029_gtFine_polygons.json
1	/data/images/201/frame0299_leftImg8bit.jpg	/data/mask/201/frame0299_gtFine_polygons.json
2	/data/images/201/frame0779_leftImg8bit.jpg	/data/mask/201/frame0779_gtFine_polygons.json
3	/data/images/201/frame1019_leftImg8bit.jpg	/data/mask/201/frame1019_gtFine_polygons.json
4	/data/images/201/frame1469_leftImg8bit.jpg	/data/mask/201/frame1469_gtFine_polygons.json

2. Structure of sample Json file



```
"imgHeight": 1080,
"imgWidth": 1920,
"objects": [
    {
        "date": "25-Jun-2019 23:13:12",
        "deleted": 0,
        "draw": true,
        "id": 0,
        "label": "sky",
        "polygon": [
            [
```



```
                0.0,
                556.1538461538462
            ],
            [
                810.0,
                565.3846153846154
            ],
            [
                1374.2307692307693,
                596.5384615384615
            ],
            [
                1919.0,
                639.2307692307692
            ],
            [
                1919.0,
                0.0
            ],
            [
                0.0,
                0.0
            ]
        ],
        "user": "cvit",
        "verified": 0
    },
```

- Each File will have 3 attributes
  - imgHeight: which tells the height of the image
  - imgWidth: which tells the width of the image
  - objects: it is a list of objects, each object will have multiple attributes,
    - label: the type of the object
    - polygon: a list of two element lists, representing the coordinates of the polygon

In [ ]:

```
new_label_clr = {'road': 10, 'parking / drivable fallback': 20,'sidewalk': 30,'non-drivable fallback / rail track': 40,\
                 'person / animal': 50, 'rider': 60, 'motorcycle / bicycle': 70, 'autorickshaw / car': 80,
          'truck / bus / vehicle fallback / trailer / caravan':90,\
                 'curb / wall':100, 'fence / guard rail':110, 'billboard / traffic sign / traffic light':120,
          'pole / polegroup / obs-str-bar-fallback':130,'vegetation':150, 'sky / fallback background':160,'unlabeled / out of roi':0,
           'ego vehicle':170, 'ground':180,'rectification border':190, 'train':200, 'building / bridge / tunnel':140, }
```

In [ ]:

```
label_clr = {'road':10, 'parking':20, 'drivable fallback':20,'sidewalk':30,'non-drivable fallback':40,'rail track':40,\
                 'person':50, 'animal':50, 'rider':60, 'motorcycle':70, 'bicycle':70, 'autorickshaw':80,\
                 'car':80, 'truck':90, 'bus':90, 'vehicle fallback':90, 'trailer':90, 'caravan':90,\
                 'curb':100, 'wall':100, 'fence':110,'guard rail':110, 'billboard':120,'traffic sign':120,\
                 'traffic light':120, 'pole':130, 'polegroup':130, 'obs-str-bar-fallback':130,'building':140,\
                 'bridge':140,'tunnel':140, 'vegetation':150, 'sky':160, 'fallback background':160,'unlabeled':0,\
                 'out of roi':0, 'ego vehicle':170, 'ground':180,'rectification border':190,\
             'train':200}
```

In [ ]:

```
len(set(label_clr))
```

Out[ ]:

```
40
```

* here we have given a number for each of object types, if you see we are having 21 different set of objects
* Note that we have multiplies each object's number with 10, that is just to make different objects look differently in the segmentation map

* Before you pass it to the models, you might need to devide the image array /10.

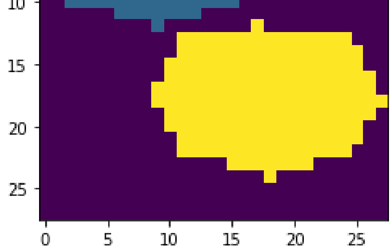
2. Extracting the polygons from the json files

Example polygon

In [ ]:

```
import math
from PIL import Image, ImageDraw
from PIL import ImagePath

# polygon sides
side=8
x1 = [ ((math.cos(th) + 1) *9, (math.sin(th) + 1) * 6) for th in [i * (2 * math.pi) / side for i in range(side)] ]
x2 = [ ((math.cos(th) + 2) *9, (math.sin(th) + 3) *6) for th in [i * (2 * math.pi) / side for i in range(side)] ]

print(x1)
print(len(x1),'\n')

img = Image.new("RGB", (28,28))
img1 = ImageDraw.Draw(img)
# please play with the fill value , fill value is color code, and no float is allowed
# writing the first polygon
img1.polygon(x1, fill = 10)
# writing the second polygon
img1.polygon(x2, fill = 30)

img=np.array(img)
# note that the filling of the values happens at the channel 1, so we are considering only the first channel here
plt.imshow(img[:,:,0])

print(img.shape,'\n')
print(img[:,:,0]//10)

im = Image.fromarray(img[:,:,0])
im.save("test_image.png")
```

```
[(18.0, 6.0), (15.363961030678928, 10.242640687119284), (9.0, 12.0), (2.636038969321073, 10.242640687119284), (0.0, 6.000000000000002), (2
.6360389693210706, 1.7573593128807152), (8.999999999999998, 0.0), (15.363961030678928, 1.757359312880714)]
8

(28, 28, 3)

[[0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
 [0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0]
 [0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0]
 [0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0]
 [0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0 0 0]
 [1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0 0 0]
 [1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0 0]
 [0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0 0 0]
 [0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0]
 [0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0]
 [0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0]
 [0 0 0 0 0 0 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
 [0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 3 0 0 0 0 0 0 0 0 0 0]
 [0 0 0 0 0 0 0 0 0 0 0 3 3 3 3 3 3 3 3 3 3 3 3 3 3 0 0 0]
 [0 0 0 0 0 0 0 0 0 0 0 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 0 0]
 [0 0 0 0 0 0 0 0 0 0 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 0 0]
 [0 0 0 0 0 0 0 0 0 0 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 0]
 [0 0 0 0 0 0 0 0 0 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 0]
 [0 0 0 0 0 0 0 0 0 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3]
 [0 0 0 0 0 0 0 0 0 0 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 0]
 [0 0 0 0 0 0 0 0 0 0 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 0 0]
 [0 0 0 0 0 0 0 0 0 0 0 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 0 0]
 [0 0 0 0 0 0 0 0 0 0 0 3 3 3 3 3 3 3 3 3 3 3 3 3 3 0 0 0]
 [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3 3 3 3 3 3 3 0 0 0 0 0 0]
 [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3 0 0 0 0 0 0 0 0 0]
 [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
 [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]
 [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]]
```



In [ ]:

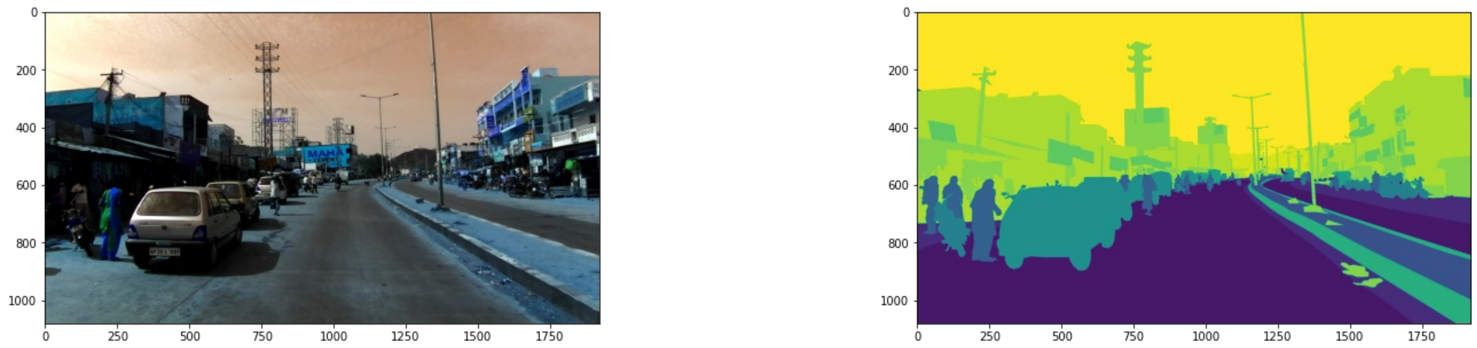
```
def get_poly(file):
    # this function will take a file name as argument
    a = pd.read_json(file)
    b = []
    # it will process all the objects in that file and returns
    for i in a['objects']:
      b.append(pd.json_normalize(i))

    b = pd.concat(b)
    # label: a list of labels for all the objects label[i] will have the corresponding vertices in vertexlist[i]
    label = list(b['label'])
    # len(label) == number of objects in the image

    # vertexlist: it should be list of list of vertices in tuple formate
    v = list(b['polygon'])

    vertexlist = []
    for i in v:
      j = []
      for k in i:
        j.append(tuple(k))
      vertexlist.append(j)

    # ex: [[(x11,y11), (x12,y12), (x13,y13) .. (x1n,y1n)]
    #     [(x21,y21), (x22,y12), (x23,y23) .. (x2n,y2n)]
    #      .....
    #     [(xm1,ym1), (xm2,ym2), (xm3,ym3) .. (xmn,ymn)]]
    # len(vertexlist) == number of objects in the image

    # * note that label[i] and vertextlist[i] are corresponds to the same object, one represents the type of the object
    # the other represents the location

    # width of the image
    w = a['imgWidth'][0]
    # height of the image
    h = a['imgHeight'][0]

    return w, h, label, vertexlist
```

In [ ]:

```
w, h, label, vertexlist = get_poly(data_df['json'].iloc[0])
img = Image.new("RGB", (w, h))        # create new canvas
img1 = ImageDraw.Draw(img)

for num in range(len(label)):
  if len(vertexlist[num]) > 1:        # vertexlist is 277 and labels also 277 so if some are less than 1 and skip them
      img1.polygon(vertexlist[num], fill = label_clr[label[num]])
  else:
      pass

img = np.array(img)
# note that the filling of the values happens at the channel 1, so we are considering only the first channel here
im = Image.fromarray(img[:,:,0] )
a = cv2.imread(data_df['image'].iloc[0])
plt.figure(figsize=(25, 5))
plt.subplot(121)
plt.imshow(a)
plt.subplot(122)
plt.imshow(im , )
# print(img[:,:,0]//10)
im.save('/content/a.png', )
img.shape
```

Out[ ]:

```
(1080, 1920, 3)
```



In [ ]:

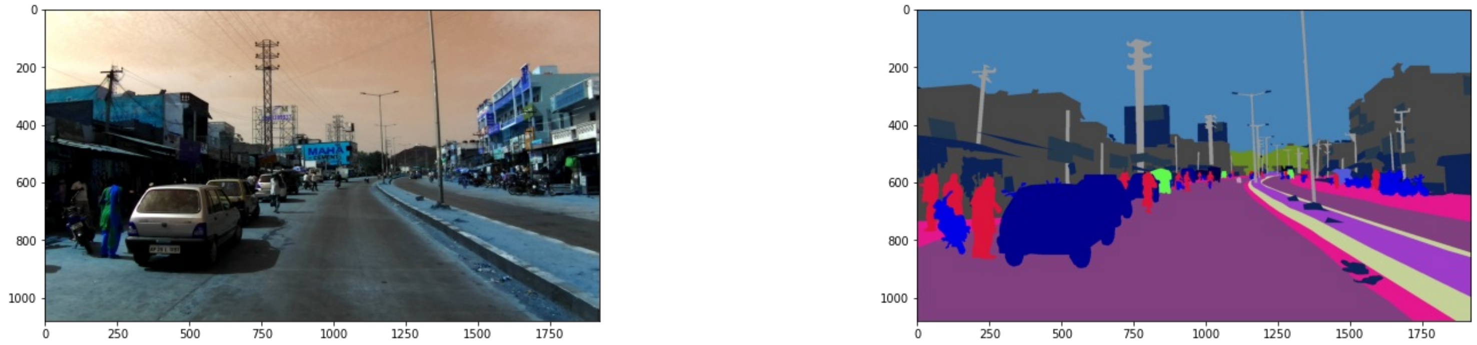
```
# Colors Dictionary of tuples

color_label_clr = {'road': (128, 64, 128), 'parking': (250, 170, 160), 'drivable fallback': (229, 23, 142),'sidewalk': (244, 35, 232),
        'non-drivable fallback': (156, 60, 200),'rail track' :(192, 192, 192), 'person': (220, 20, 60), 'animal': (199, 151, 187),
        'rider': (255, 0, 0), 'motorcycle': (0, 0, 230), 'bicycle': (119, 11, 32), 'autorickshaw': (99, 250, 80), 'car': (0, 0, 142),
        'truck': (0, 0, 70), 'bus': (0, 60, 100), 'vehicle fallback': (82, 92, 214), 'trailer': (50, 150, 250),
        'caravan': (0, 0, 90), 'curb': (196, 209, 152), 'wall': (102, 102, 156), 'fence': (190, 153, 153),'guard rail': (180, 165, 180),
        'billboard': (37, 58, 77),'traffic sign': (220, 220, 0), 'traffic light': (250, 170, 30), 'pole': (153, 153, 153),
        'polegroup': (153, 153, 153), 'obs-str-bar-fallback': (11, 35, 88),'building': (70, 70, 70), 'bridge': (150, 100, 100),
        'tunnel': (150, 120, 90), 'vegetation': (107, 142, 35), 'sky': (70, 130, 180), 'fallback background': (225, 130, 123),
        'unlabeled': (0, 0, 0),  'out of roi': (0, 0, 0), 'ego vehicle': (0, 0, 0), 'ground':(244, 164, 96) ,
        'rectification border': (0, 0, 0),    'train':  (35, 105, 70)}
```

In [ ]:

```
w, h, label, vertexlist = get_poly(data_df['json'].iloc[0])
img = Image.new("RGB", (w, h))       # create new canvas
img1 = ImageDraw.Draw(img)

for num in range(len(label)):
  if len(vertexlist[num]) > 1:        # vertexlist is 277 and labels also 277 so if some are less than 1 and skip them
    img1.polygon(vertexlist[num], fill = color_label_clr[label[num]])
  else:
    pass

img = np.array(img)
# note that the filling of the values happens at the channel 1, so we are considering only the first channel here
im = Image.fromarray(img[:,:,:] )
a = cv2.imread(data_df['image'].iloc[0])
plt.figure(figsize=(25, 5))
plt.subplot(121)
plt.imshow(a)
plt.subplot(122)
plt.imshow(im , )
# print(img[:,:,0]//10)
im.save('/content/a.png', )
img.shape
```

Out[ ]:

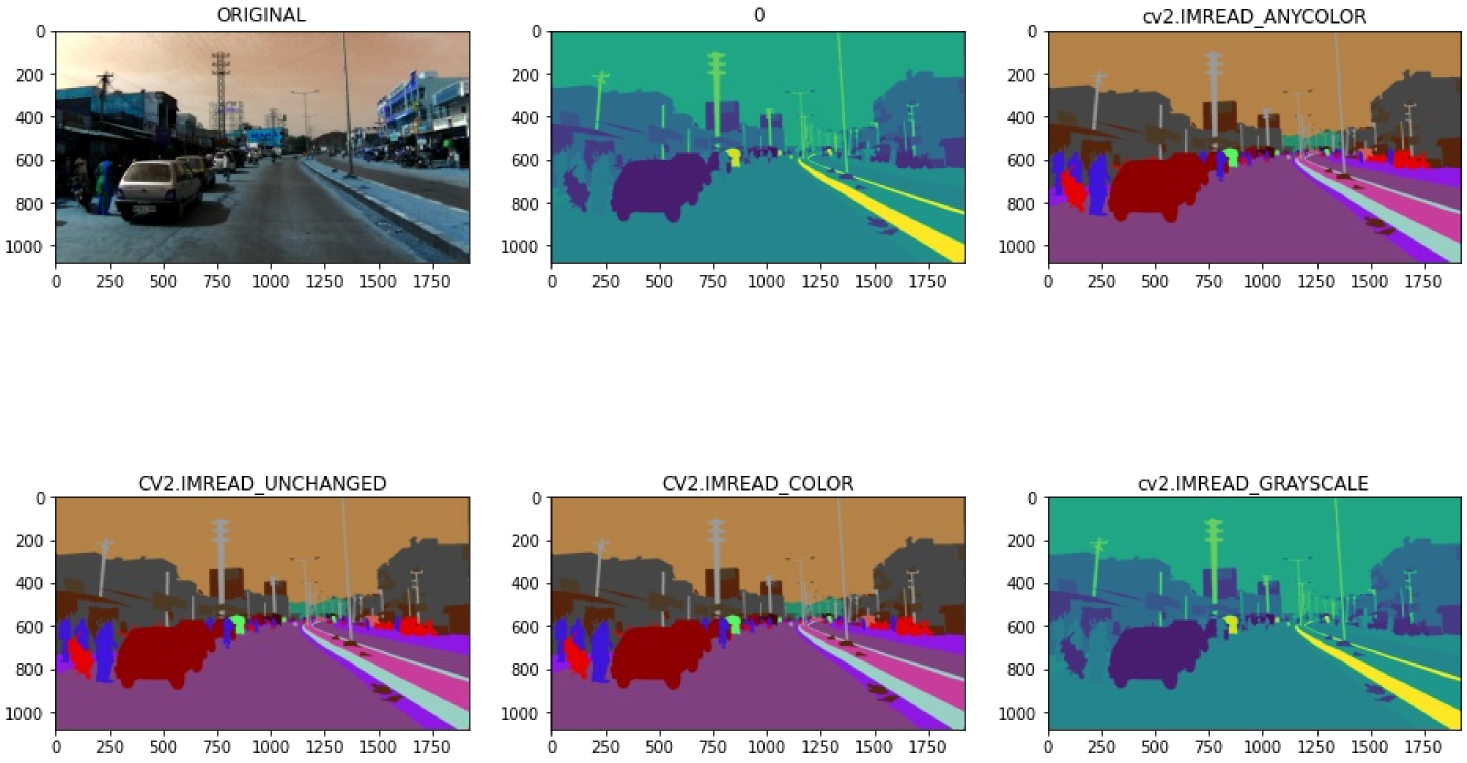
```
(1080, 1920, 3)
```



In [ ]:

```
f, ax = plt.subplots(2,3, figsize = (16, 10))

ax[0,0].imshow(cv2.imread(data_df['image'].iloc[0]))
ax[0,0].title.set_text('ORIGINAL')
ax[0,1].imshow(cv2.imread('/content/a.png', 0))
```

```
ax[0,1].imshow(cv2.imread('/content/a.png', 0))
ax[0,1].title.set_text('0')
ax[0,2].imshow(cv2.imread('/content/a.png', cv2.IMREAD_ANYCOLOR))
ax[0,2].title.set_text('cv2.IMREAD_ANYCOLOR')
ax[1,0].imshow(cv2.imread('/content/a.png', cv2.IMREAD_UNCHANGED))
ax[1,0].title.set_text('CV2.IMREAD_UNCHANGED')
ax[1,1].imshow(cv2.imread('/content/a.png', cv2.IMREAD_COLOR))
ax[1,1].title.set_text('CV2.IMREAD_COLOR')
ax[1,2].imshow(cv2.imread('/content/a.png', cv2.IMREAD_GRAYSCALE))
ax[1,2].title.set_text('cv2.IMREAD_GRAYSCALE')
plt.show()
```



In [ ]:

```
from tqdm import tqdm_notebook

def compute_masks(data_df):
  # after you have computed the vertexlist, plot that polygone in image like this

  # we create these paths to save our png files to mask folder
  #https://www.geeksforgeeks.org/python-os-mkdir-method/
  # path1 = os.path.join('/data/' ,'output')
  # os.mkdir(path1)
  mask = []
  for i in tqdm_notebook(list(data_df['json'])):

   first = i[11:14]                         # number to place for saved image path
   path2 = os.path.join('/data/output/', str(first) + '/')
   os.makedirs(path2, exist_ok = True)  # creating new dir and path to save images and exist_ok means in for loop no error throws

   w, h, label, vertexlist = get_poly(i) # collect 4 elements

   img = Image.new("RGB", (w, h))       # create new canvas
   img1 = ImageDraw.Draw(img)

   for num in range(len(label)):
    if len(vertexlist[num]) > 1:       # vertexlist is 277 and labels also 277 so if some are less than 1 and skip them
     img1.polygon(vertexlist[num], fill = label_clr[label[num]])
    else:
     pass

   img = np.array(img)
   # note that the filling of the values happens at the channel 1, so we are considering only the first channel here

   im = Image.fromarray(img[:,:,0])
   # after drawing all the polygons that we collected from json file,
   # you need to store that image in the folder like this "data/output/scene/framenumber_gtFine_polygons.png

   op = '/data/output//.png'
   index1 = op.find('/.')
   op1 = op[:index1] + first + op[index1:]
   index2 = op1.find('.p')
```

```
        op2 = op1[:index2] + i[15:-5] + op1[index2:]

        im.save(op2)
        mask.append(op2)

    # after saving the image into disk, store the path in a list
    # after storing all the paths, add a column to the data_df['mask'] ex: data_df['mask']= mask_paths
    data_df['mask'] = mask
    return  data_df
```

In [ ]:

```
data_df = compute_masks(data_df)
data_df.head()
```

```
/usr/local/lib/python3.6/dist-packages/ipykernel_launcher.py:11: TqdmDeprecationWarning: This function will be removed in tqdm==5.0.0
Please use `tqdm.notebook.tqdm` instead of `tqdm.tqdm_notebook`
  # This is added back by InteractiveShellApp.init_path()
```

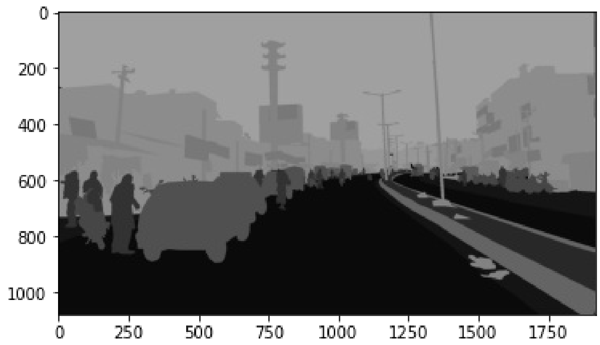
Out[ ]:

	image	json	mask
0	/data/images/201/frame0029_leftImg8bit.jpg	/data/mask/201/frame0029_gtFine_polygons.json	/data/output/201/frame0029_gtFine_polygons.png
1	/data/images/201/frame0299_leftImg8bit.jpg	/data/mask/201/frame0299_gtFine_polygons.json	/data/output/201/frame0299_gtFine_polygons.png
2	/data/images/201/frame0779_leftImg8bit.jpg	/data/mask/201/frame0779_gtFine_polygons.json	/data/output/201/frame0779_gtFine_polygons.png
3	/data/images/201/frame1019_leftImg8bit.jpg	/data/mask/201/frame1019_gtFine_polygons.json	/data/output/201/frame1019_gtFine_polygons.png
4	/data/images/201/frame1469_leftImg8bit.jpg	/data/mask/201/frame1469_gtFine_polygons.json	/data/output/201/frame1469_gtFine_polygons.png

In [ ]:

```
def grader():
    url = "https://i.imgur.com/4XSUlHk.png"
    url_response = urllib.request.urlopen(url)
    img_array = np.array(bytearray(url_response.read()), dtype=np.uint8)
    img = cv2.imdecode(img_array, -1)
    my_img = cv2.imread('/data/output/201/frame0029_gtFine_polygons.png')    #
    plt.imshow(my_img)
    print((my_img[:,:,0]==img).all())
    print(np.unique(img))
    print(np.unique(my_img[:,:,0]))
    data_df.to_csv('preprocessed_data.csv', index=False)
grader()
```

```
True
[  0  10  20  40  50  60  70  80  90 100 120 130 140 150 160]
[  0  10  20  40  50  60  70  80  90 100 120 130 140 150 160]
```

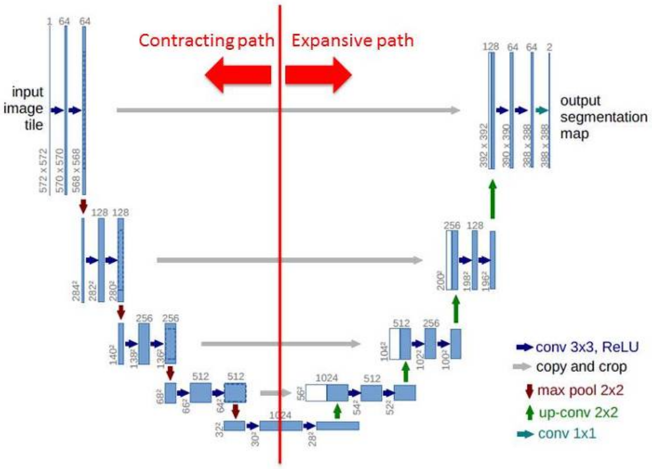


Task 2: Applying Unet to segment the images

* please check the paper: https://arxiv.org/abs/1505.04597

*

Network Architecture



* As a part of this assignment we won't writingt this whole architecture, rather we will be doing transfer learning

* please check the library https://github.com/qubvel/segmentation_models

* You can install it like this "pip install -U segmentation-models==0.2.1", even in google colab you can install the same with "!pip install -U segmentation-models==0.2.1"

* Check the reference notebook in which we have solved one end to end case study of image forgery detection using same unet

* The number of channels in the output will depend on the number of classes in your data, since we know that we are having 21 classes, the number of channels in the output will also be 21

* **This is where we want you to explore, how do you featurize your created segmentation map, note that the original map will be of (w, h, 1) and the output will be (w, h, 21) how will you calculate the loss**, you can check the examples in segmentation github

* please use the loss function that is used in the refence notebooks

In [ ]:

```
pip install segmentation-models==1.0.1
```

```
Collecting segmentation-models==1.0.1
  Downloading https://files.pythonhosted.org/packages/da/b9/4a183518c21689a56b834eaaa45cad242d9ec09a4360b5b10139f23c63f4/segmentation
_models-1.0.1-py3-none-any.whl
Collecting efficientnet==1.0.0
  Downloading https://files.pythonhosted.org/packages/97/82/f3ae07316f0461417dc54affab6e86ab188a5a22f33176d35271628b96e0/efficientnet-1.0
.0-py3-none-any.whl
Collecting image-classifiers==1.0.0
  Downloading https://files.pythonhosted.org/packages/81/98/6f84720e299a4942ab80df5f76ab97b7828b24d1de5e9b2cbbe6073228b7/image_classif
iers-1.0.0-py3-none-any.whl
Requirement already satisfied: keras-applications<=1.0.8,>=1.0.7 in /usr/local/lib/python3.6/dist-packages (from segmentation-models==1.0.1) (1.0.8
)
Requirement already satisfied: scikit-image in /usr/local/lib/python3.6/dist-packages (from efficientnet==1.0.0->segmentation-models==1.0.1) (0.16.2)
Requirement already satisfied: numpy>=1.9.1 in /usr/local/lib/python3.6/dist-packages (from keras-applications<=1.0.8,>=1.0.7->segmentation-model
s==1.0.1) (1.18.5)
Requirement already satisfied: h5py in /usr/local/lib/python3.6/dist-packages (from keras-applications<=1.0.8,>=1.0.7->segmentation-models==1.0.1)
(2.10.0)
Requirement already satisfied: pillow>=4.3.0 in /usr/local/lib/python3.6/dist-packages (from scikit-image->efficientnet==1.0.0->segmentation-models=
=1.0.1) (7.0.0)
Requirement already satisfied: scipy>=0.19.0 in /usr/local/lib/python3.6/dist-packages (from scikit-image->efficientnet==1.0.0->segmentation-models
==1.0.1) (1.4.1)
Requirement already satisfied: PyWavelets>=0.4.0 in /usr/local/lib/python3.6/dist-packages (from scikit-image->efficientnet==1.0.0->segmentation-m
odels==1.0.1) (1.1.1)
Requirement already satisfied: imageio>=2.3.0 in /usr/local/lib/python3.6/dist-packages (from scikit-image->efficientnet==1.0.0->segmentation-model
s==1.0.1) (2.4.1)
Requirement already satisfied: networkx>=2.0 in /usr/local/lib/python3.6/dist-packages (from scikit-image->efficientnet==1.0.0->segmentation-models
==1.0.1) (2.4)
Requirement already satisfied: matplotlib!=3.0.0,>=2.0.0 in /usr/local/lib/python3.6/dist-packages (from scikit-image->efficientnet==1.0.0->segmentati
on-models==1.0.1) (3.2.1)
Requirement already satisfied: six in /usr/local/lib/python3.6/dist-packages (from h5py->keras-applications<=1.0.8,>=1.0.7->segmentation-models==
1.0.1) (1.12.0)
Requirement already satisfied: decorator>=4.3.0 in /usr/local/lib/python3.6/dist-packages (from networkx>=2.0->scikit-image->efficientnet==1.0.0->se
gmentation-models==1.0.1) (4.4.2)
Requirement already satisfied: pyparsing!=2.0.4,!=2.1.2,!=2.1.6,>=2.0.1 in /usr/local/lib/python3.6/dist-packages (from matplotlib!=3.0.0,>=2.0.0->scik
Requirement already satisfied: pyparsing!=2.0.4,!=2.1.2,!=2.1.6,>=2.0.1 in /usr/local/lib/python3.6/dist-packages (from matplotlib!=3.0.0,>=2.0.0->scik
it-image->efficientnet==1.0.0->segmentation-models==1.0.1) (2.4.7)
Requirement already satisfied: kiwisolver>=1.0.1 in /usr/local/lib/python3.6/dist-packages (from matplotlib!=3.0.0,>=2.0.0->scikit-image->efficientnet=
=1.0.0->segmentation-models==1.0.1) (1.2.0)
Requirement already satisfied: python-dateutil>=2.1 in /usr/local/lib/python3.6/dist-packages (from matplotlib!=3.0.0,>=2.0.0->scikit-image->efficientn
et==1.0.0->segmentation-models==1.0.1) (2.8.1)
Requirement already satisfied: cycler>=0.10 in /usr/local/lib/python3.6/dist-packages (from matplotlib!=3.0.0,>=2.0.0->scikit-image->efficientnet==1.0
.0->segmentation-models==1.0.1) (0.10.0)
Installing collected packages: efficientnet, image-classifiers, segmentation-models
Successfully installed efficientnet-1.0.0 image-classifiers-1.0.0 segmentation-models-1.0.1
```

In [ ]:

```
# !pip install imgaug
# ! pip install --upgrade keras
```

In [ ]:

```
import tensorflow as tf
# tf.enable_eager_execution()
import os
import numpy as np
import pandas as pd
import cv2
import matplotlib.pyplot as plt
# from hilbert import hilbertCurve
import imgaug.augmenters as iaa
import numpy as np
# import albumentations as A
os.environ['TF_FORCE_GPU_ALLOW_GROWTH'] = 'true'

from tensorflow.keras import layers
# https://stackoverflow.com/a/59239355/10219869
from tensorflow.keras.layers import Dense,Input,Conv2D,MaxPool2D,Activation,Dropout,Flatten, LSTM, BatchNormalization, ReLU, Reshape
from tensorflow.keras.models import Model
import random as rn
# https://stackoverflow.com/a/59019134/10219869
from keras.callbacks import ModelCheckpoint, ReduceLROnPlateau
```

```
Using TensorFlow backend.
```

In [ ]:

```
from sklearn.model_selection import train_test_split
X_test, X_train = train_test_split(data_df[['image', 'mask']], test_size=0.90, random_state=42)
```

In [ ]:

```
# this is combined of x (image) and y (mask) labels.
print('Shape of X_train:', X_train.shape)
print('Shape of X_test:', X_test.shape)
```

```
Shape of X_train: (3608, 2)
Shape of X_test: (400, 2)
```

In [ ]:

```
# we are importing the pretrained unet from the segmentation models
# https://github.com/qubvel/segmentation_models
import segmentation_models as sm
from segmentation_models import Unet
# sm.set_framework('tf.keras')
tf.keras.backend.set_image_data_format('channels_last')

# loading the unet model and using the resnet 34 and initilized weights with imagenet weights
# "classes" :different types of classes in the dataset 40
model = None
model = Unet( backbone_name= 'resnet34', encoder_weights='imagenet', classes= len(new_label_clr.keys()),
          activation='softmax', input_shape=(None, None,3))
```

```
Segmentation Models: using `keras` framework.
Downloading data from https://github.com/qubvel/classification_models/releases/download/0.0.1/resnet34_imagenet_1000_no_top.h5
85524480/85521592 [==============================] - 8s 0us/step
```

In [ ]:

```
"""for layer in model.layers:
  if layer.name != 'decoder_stage0_upsampling':
    layer.trainable = False
  else:
    break
"""
model.summary()
```

```
Model: "model_2"
__________________________________________________________________________________________________
Layer (type)                    Output Shape         Param #     Connected to
==================================================================================================
data (InputLayer)               (None, None, None, 3 0
__________________________________________________________________________________________________
bn_data (BatchNormalization)    (None, None, None, 3 9           data[0][0]
__________________________________________________________________________________________________
zero_padding2d_1 (ZeroPadding2D (None, None, None, 3 0           bn_data[0][0]
__________________________________________________________________________________________________
conv0 (Conv2D)                  (None, None, None, 6 9408        zero_padding2d_1[0][0]
__________________________________________________________________________________________________
bn0 (BatchNormalization)        (None, None, None, 6 256         conv0[0][0]
__________________________________________________________________________________________________
relu0 (Activation)              (None, None, None, 6 0           bn0[0][0]
__________________________________________________________________________________________________
zero_padding2d_2 (ZeroPadding2D (None, None, None, 6 0           relu0[0][0]
__________________________________________________________________________________________________
pooling0 (MaxPooling2D)         (None, None, None, 6 0           zero_padding2d_2[0][0]
__________________________________________________________________________________________________
stage1_unit1_bn1 (BatchNormaliz (None, None, None, 6 256         pooling0[0][0]
__________________________________________________________________________________________________
stage1_unit1_relu1 (Activation) (None, None, None, 6 0           stage1_unit1_bn1[0][0]
__________________________________________________________________________________________________
zero_padding2d_3 (ZeroPadding2D (None, None, None, 6 0           stage1_unit1_relu1[0][0]
__________________________________________________________________________________________________
stage1_unit1_conv1 (Conv2D)     (None, None, None, 6 36864       zero_padding2d_3[0][0]
__________________________________________________________________________________________________
stage1_unit1_bn2 (BatchNormaliz (None, None, None, 6 256         stage1_unit1_conv1[0][0]
__________________________________________________________________________________________________
stage1_unit1_relu2 (Activation) (None, None, None, 6 0           stage1_unit1_bn2[0][0]
__________________________________________________________________________________________________
zero_padding2d_4 (ZeroPadding2D (None, None, None, 6 0           stage1_unit1_relu2[0][0]
__________________________________________________________________________________________________
stage1_unit1_conv2 (Conv2D)     (None, None, None, 6 36864       zero_padding2d_4[0][0]
__________________________________________________________________________________________________
stage1_unit1_sc (Conv2D)        (None, None, None, 6 4096        stage1_unit1_relu1[0][0]
__________________________________________________________________________________________________
add_1 (Add)                     (None, None, None, 6 0           stage1_unit1_conv2[0][0]
                                                                 stage1_unit1_sc[0][0]
__________________________________________________________________________________________________
stage1_unit2_bn1 (BatchNormaliz (None, None, None, 6 256         add_1[0][0]
__________________________________________________________________________________________________
stage1_unit2_relu1 (Activation) (None, None, None, 6 0           stage1_unit2_bn1[0][0]
__________________________________________________________________________________________________
zero_padding2d_5 (ZeroPadding2D (None, None, None, 6 0           stage1_unit2_relu1[0][0]
__________________________________________________________________________________________________
stage1_unit2_conv1 (Conv2D)     (None, None, None, 6 36864       zero_padding2d_5[0][0]
__________________________________________________________________________________________________
stage1_unit2_bn2 (BatchNormaliz (None, None, None, 6 256         stage1_unit2_conv1[0][0]
__________________________________________________________________________________________________
stage1_unit2_relu2 (Activation) (None, None, None, 6 0           stage1_unit2_bn2[0][0]
__________________________________________________________________________________________________
zero_padding2d_6 (ZeroPadding2D (None, None, None, 6 0           stage1_unit2_relu2[0][0]
__________________________________________________________________________________________________
stage1_unit2_conv2 (Conv2D)     (None, None, None, 6 36864       zero_padding2d_6[0][0]
__________________________________________________________________________________________________
add_2 (Add)                     (None, None, None, 6 0           stage1_unit2_conv2[0][0]
                                                                 add_1[0][0]
__________________________________________________________________________________________________
stage1_unit3_bn1 (BatchNormaliz (None, None, None, 6 256         add_2[0][0]
__________________________________________________________________________________________________
stage1_unit3_relu1 (Activation) (None, None, None, 6 0           stage1_unit3_bn1[0][0]
__________________________________________________________________________________________________
zero_padding2d_7 (ZeroPadding2D (None, None, None, 6 0           stage1_unit3_relu1[0][0]
__________________________________________________________________________________________________
stage1_unit3_conv1 (Conv2D)     (None, None, None, 6 36864       zero_padding2d_7[0][0]
__________________________________________________________________________________________________
stage1_unit3_bn2 (BatchNormaliz (None, None, None, 6 256         stage1_unit3_conv1[0][0]
__________________________________________________________________________________________________
stage1_unit3_relu2 (Activation) (None, None, None, 6 0           stage1_unit3_bn2[0][0]
__________________________________________________________________________________________________
zero_padding2d_8 (ZeroPadding2D (None, None, None, 6 0           stage1_unit3_relu2[0][0]
__________________________________________________________________________________________________
stage1_unit3_conv2 (Conv2D)     (None, None, None, 6 36864       zero_padding2d_8[0][0]
__________________________________________________________________________________________________
add_3 (Add)                     (None, None, None, 6 0           stage1_unit3_conv2[0][0]
                                                                 add_2[0][0]
__________________________________________________________________________________________________
stage2_unit1_bn1 (BatchNormaliz (None, None, None, 6 256         add_3[0][0]
__________________________________________________________________________________________________
stage2_unit1_relu1 (Activation) (None, None, None, 6 0           stage2_unit1_bn1[0][0]
__________________________________________________________________________________________________
zero_padding2d_9 (ZeroPadding2D (None, None, None, 6 0           stage2_unit1_relu1[0][0]
__________________________________________________________________________________________________
stage2_unit1_conv1 (Conv2D)     (None, None, None, 1 73728       zero_padding2d_9[0][0]
__________________________________________________________________________________________________
stage2_unit1_bn2 (BatchNormaliz (None, None, None, 1 512         stage2_unit1_conv1[0][0]
__________________________________________________________________________________________________
stage2_unit1_relu2 (Activation) (None, None, None, 1 0           stage2_unit1_bn2[0][0]
__________________________________________________________________________________________________
zero_padding2d_10 (ZeroPadding2 (None, None, None, 1 0           stage2_unit1_relu2[0][0]
__________________________________________________________________________________________________
stage2_unit1_conv2 (Conv2D)     (None, None, None, 1 147456      zero_padding2d_10[0][0]
__________________________________________________________________________________________________
stage2_unit1_sc (Conv2D)        (None, None, None, 1 8192        stage2_unit1_relu1[0][0]
__________________________________________________________________________________________________
add_4 (Add)                     (None, None, None, 1 0           stage2_unit1_conv2[0][0]
                                                                 stage2_unit1_sc[0][0]
__________________________________________________________________________________________________
stage2_unit2_bn1 (BatchNormaliz (None, None, None, 1 512         add_4[0][0]
__________________________________________________________________________________________________
stage2_unit2_relu1 (Activation) (None, None, None, 1 0           stage2_unit2_bn1[0][0]
__________________________________________________________________________________________________
zero_padding2d_11 (ZeroPadding2 (None, None, None, 1 0           stage2_unit2_relu1[0][0]
__________________________________________________________________________________________________
stage2_unit2_conv1 (Conv2D)     (None, None, None, 1 147456      zero_padding2d_11[0][0]
__________________________________________________________________________________________________
stage2_unit2_bn2 (BatchNormaliz (None, None, None, 1 512         stage2_unit2_conv1[0][0]
__________________________________________________________________________________________________
stage2_unit2_relu2 (Activation) (None, None, None, 1 0           stage2_unit2_bn2[0][0]
__________________________________________________________________________________________________
zero_padding2d_12 (ZeroPadding2 (None, None, None, 1 0           stage2_unit2_relu2[0][0]
__________________________________________________________________________________________________
stage2_unit2_conv2 (Conv2D)     (None, None, None, 1 147456      zero_padding2d_12[0][0]
__________________________________________________________________________________________________
add_5 (Add)                     (None, None, None, 1 0           stage2_unit2_conv2[0][0]
                                                                 add_4[0][0]
__________________________________________________________________________________________________
stage2_unit3_bn1 (BatchNormaliz (None, None, None, 1 512         add_5[0][0]
__________________________________________________________________________________________________
stage2_unit3_relu1 (Activation) (None, None, None, 1 0           stage2_unit3_bn1[0][0]
__________________________________________________________________________________________________
zero_padding2d_13 (ZeroPadding2 (None, None, None, 1 0           stage2_unit3_relu1[0][0]
__________________________________________________________________________________________________
stage2_unit3_conv1 (Conv2D)     (None, None, None, 1 147456      zero_padding2d_13[0][0]
__________________________________________________________________________________________________
stage2_unit3_bn2 (BatchNormaliz (None, None, None, 1 512         stage2_unit3_conv1[0][0]
__________________________________________________________________________________________________
stage2_unit3_relu2 (Activation) (None, None, None, 1 0           stage2_unit3_bn2[0][0]
__________________________________________________________________________________________________
zero_padding2d_14 (ZeroPadding2 (None, None, None, 1 0           stage2_unit3_relu2[0][0]
__________________________________________________________________________________________________
stage2_unit3_conv2 (Conv2D)     (None, None, None, 1 147456      zero_padding2d_14[0][0]
__________________________________________________________________________________________________
add_6 (Add)                     (None, None, None, 1 0           stage2_unit3_conv2[0][0]
                                                                 add_5[0][0]
__________________________________________________________________________________________________
stage2_unit4_bn1 (BatchNormaliz (None, None, None, 1 512         add_6[0][0]
__________________________________________________________________________________________________
stage2_unit4_relu1 (Activation) (None, None, None, 1 0           stage2_unit4_bn1[0][0]
__________________________________________________________________________________________________
zero_padding2d_15 (ZeroPadding2 (None, None, None, 1 0           stage2_unit4_relu1[0][0]
__________________________________________________________________________________________________
stage2_unit4_conv1 (Conv2D)     (None, None, None, 1 147456      zero_padding2d_15[0][0]
__________________________________________________________________________________________________
stage2_unit4_bn2 (BatchNormaliz (None, None, None, 1 512         stage2_unit4_conv1[0][0]
__________________________________________________________________________________________________
stage2_unit4_relu2 (Activation) (None, None, None, 1 0           stage2_unit4_bn2[0][0]
__________________________________________________________________________________________________
zero_padding2d_16 (ZeroPadding2 (None, None, None, 1 0           stage2_unit4_relu2[0][0]
__________________________________________________________________________________________________
stage2_unit4_conv2 (Conv2D)     (None, None, None, 1 147456      zero_padding2d_16[0][0]
__________________________________________________________________________________________________
add_7 (Add)                     (None, None, None, 1 0           stage2_unit4_conv2[0][0]
                                                                 add_6[0][0]
```

```
                                                                  add_6[0][0]
__________________________________________________________________________________________________
stage3_unit1_bn1 (BatchNormaliz (None, None, None, 1  512         add_7[0][0]
__________________________________________________________________________________________________
stage3_unit1_relu1 (Activation) (None, None, None, 1  0           stage3_unit1_bn1[0][0]
__________________________________________________________________________________________________
zero_padding2d_17 (ZeroPadding2 (None, None, None, 1  0           stage3_unit1_relu1[0][0]
__________________________________________________________________________________________________
stage3_unit1_conv1 (Conv2D)     (None, None, None, 2  294912      zero_padding2d_17[0][0]
__________________________________________________________________________________________________
stage3_unit1_bn2 (BatchNormaliz (None, None, None, 2  1024        stage3_unit1_conv1[0][0]
__________________________________________________________________________________________________
stage3_unit1_relu2 (Activation) (None, None, None, 2  0           stage3_unit1_bn2[0][0]
__________________________________________________________________________________________________
zero_padding2d_18 (ZeroPadding2 (None, None, None, 2  0           stage3_unit1_relu2[0][0]
__________________________________________________________________________________________________
stage3_unit1_conv2 (Conv2D)     (None, None, None, 2  589824      zero_padding2d_18[0][0]
__________________________________________________________________________________________________
stage3_unit1_sc (Conv2D)        (None, None, None, 2  32768       stage3_unit1_relu1[0][0]
__________________________________________________________________________________________________
add_8 (Add)                     (None, None, None, 2  0           stage3_unit1_conv2[0][0]
                                                                  stage3_unit1_sc[0][0]
__________________________________________________________________________________________________
stage3_unit2_bn1 (BatchNormaliz (None, None, None, 2  1024        add_8[0][0]
__________________________________________________________________________________________________
stage3_unit2_relu1 (Activation) (None, None, None, 2  0           stage3_unit2_bn1[0][0]
__________________________________________________________________________________________________
zero_padding2d_19 (ZeroPadding2 (None, None, None, 2  0           stage3_unit2_relu1[0][0]
__________________________________________________________________________________________________
stage3_unit2_conv1 (Conv2D)     (None, None, None, 2  589824      zero_padding2d_19[0][0]
__________________________________________________________________________________________________
stage3_unit2_bn2 (BatchNormaliz (None, None, None, 2  1024        stage3_unit2_conv1[0][0]
__________________________________________________________________________________________________
stage3_unit2_relu2 (Activation) (None, None, None, 2  0           stage3_unit2_bn2[0][0]
__________________________________________________________________________________________________
zero_padding2d_20 (ZeroPadding2 (None, None, None, 2  0           stage3_unit2_relu2[0][0]
__________________________________________________________________________________________________
stage3_unit2_conv2 (Conv2D)     (None, None, None, 2  589824      zero_padding2d_20[0][0]
__________________________________________________________________________________________________
add_9 (Add)                     (None, None, None, 2  0           stage3_unit2_conv2[0][0]
                                                                  add_8[0][0]
__________________________________________________________________________________________________
stage3_unit3_bn1 (BatchNormaliz (None, None, None, 2  1024        add_9[0][0]
__________________________________________________________________________________________________
stage3_unit3_relu1 (Activation) (None, None, None, 2  0           stage3_unit3_bn1[0][0]
__________________________________________________________________________________________________
zero_padding2d_21 (ZeroPadding2 (None, None, None, 2  0           stage3_unit3_relu1[0][0]
__________________________________________________________________________________________________
stage3_unit3_conv1 (Conv2D)     (None, None, None, 2  589824      zero_padding2d_21[0][0]
__________________________________________________________________________________________________
stage3_unit3_bn2 (BatchNormaliz (None, None, None, 2  1024        stage3_unit3_conv1[0][0]
__________________________________________________________________________________________________
stage3_unit3_relu2 (Activation) (None, None, None, 2  0           stage3_unit3_bn2[0][0]
__________________________________________________________________________________________________
zero_padding2d_22 (ZeroPadding2 (None, None, None, 2  0           stage3_unit3_relu2[0][0]
__________________________________________________________________________________________________
stage3_unit3_conv2 (Conv2D)     (None, None, None, 2  589824      zero_padding2d_22[0][0]
__________________________________________________________________________________________________
add_10 (Add)                    (None, None, None, 2  0           stage3_unit3_conv2[0][0]
                                                                  add_9[0][0]
__________________________________________________________________________________________________
stage3_unit4_bn1 (BatchNormaliz (None, None, None, 2  1024        add_10[0][0]
__________________________________________________________________________________________________
stage3_unit4_relu1 (Activation) (None, None, None, 2  0           stage3_unit4_bn1[0][0]
__________________________________________________________________________________________________
zero_padding2d_23 (ZeroPadding2 (None, None, None, 2  0           stage3_unit4_relu1[0][0]
__________________________________________________________________________________________________
stage3_unit4_conv1 (Conv2D)     (None, None, None, 2  589824      zero_padding2d_23[0][0]
__________________________________________________________________________________________________
stage3_unit4_bn2 (BatchNormaliz (None, None, None, 2  1024        stage3_unit4_conv1[0][0]
__________________________________________________________________________________________________
stage3_unit4_relu2 (Activation) (None, None, None, 2  0           stage3_unit4_bn2[0][0]
__________________________________________________________________________________________________
zero_padding2d_24 (ZeroPadding2 (None, None, None, 2  0           stage3_unit4_relu2[0][0]
__________________________________________________________________________________________________
stage3_unit4_conv2 (Conv2D)     (None, None, None, 2  589824      zero_padding2d_24[0][0]
__________________________________________________________________________________________________
add_11 (Add)                    (None, None, None, 2  0           stage3_unit4_conv2[0][0]
                                                                  add_10[0][0]
__________________________________________________________________________________________________
stage3_unit5_bn1 (BatchNormaliz (None, None, None, 2  1024        add_11[0][0]
__________________________________________________________________________________________________
stage3_unit5_relu1 (Activation) (None, None, None, 2  0           stage3_unit5_bn1[0][0]
__________________________________________________________________________________________________
zero_padding2d_25 (ZeroPadding2 (None, None, None, 2 0           stage3_unit5_relu1[0][0]
__________________________________________________________________________________________________
stage3_unit5_conv1 (Conv2D)     (None, None, None, 2 589824      zero_padding2d_25[0][0]
__________________________________________________________________________________________________
stage3_unit5_bn2 (BatchNormaliz (None, None, None, 2 1024        stage3_unit5_conv1[0][0]
__________________________________________________________________________________________________
stage3_unit5_relu2 (Activation) (None, None, None, 2 0           stage3_unit5_bn2[0][0]
__________________________________________________________________________________________________
zero_padding2d_26 (ZeroPadding2 (None, None, None, 2 0           stage3_unit5_relu2[0][0]
__________________________________________________________________________________________________
stage3_unit5_conv2 (Conv2D)     (None, None, None, 2 589824      zero_padding2d_26[0][0]
__________________________________________________________________________________________________
add_12 (Add)                    (None, None, None, 2 0           stage3_unit5_conv2[0][0]
                                                                 add_11[0][0]
__________________________________________________________________________________________________
stage3_unit6_bn1 (BatchNormaliz (None, None, None, 2 1024        add_12[0][0]
__________________________________________________________________________________________________
stage3_unit6_relu1 (Activation) (None, None, None, 2 0           stage3_unit6_bn1[0][0]
__________________________________________________________________________________________________
zero_padding2d_27 (ZeroPadding2 (None, None, None, 2 0           stage3_unit6_relu1[0][0]
__________________________________________________________________________________________________
stage3_unit6_conv1 (Conv2D)     (None, None, None, 2 589824      zero_padding2d_27[0][0]
__________________________________________________________________________________________________
stage3_unit6_bn2 (BatchNormaliz (None, None, None, 2 1024        stage3_unit6_conv1[0][0]
__________________________________________________________________________________________________
stage3_unit6_relu2 (Activation) (None, None, None, 2 0           stage3_unit6_bn2[0][0]
__________________________________________________________________________________________________
zero_padding2d_28 (ZeroPadding2 (None, None, None, 2 0           stage3_unit6_relu2[0][0]
__________________________________________________________________________________________________
stage3_unit6_conv2 (Conv2D)     (None, None, None, 2 589824      zero_padding2d_28[0][0]
__________________________________________________________________________________________________
add_13 (Add)                    (None, None, None, 2 0           stage3_unit6_conv2[0][0]
                                                                 add_12[0][0]
__________________________________________________________________________________________________
stage4_unit1_bn1 (BatchNormaliz (None, None, None, 2 1024        add_13[0][0]
__________________________________________________________________________________________________
stage4_unit1_relu1 (Activation) (None, None, None, 2 0           stage4_unit1_bn1[0][0]
__________________________________________________________________________________________________
zero_padding2d_29 (ZeroPadding2 (None, None, None, 2 0           stage4_unit1_relu1[0][0]
__________________________________________________________________________________________________
stage4_unit1_conv1 (Conv2D)     (None, None, None, 5 1179648     zero_padding2d_29[0][0]
__________________________________________________________________________________________________
stage4_unit1_bn2 (BatchNormaliz (None, None, None, 5 2048        stage4_unit1_conv1[0][0]
__________________________________________________________________________________________________
stage4_unit1_relu2 (Activation) (None, None, None, 5 0           stage4_unit1_bn2[0][0]
__________________________________________________________________________________________________
zero_padding2d_30 (ZeroPadding2 (None, None, None, 5 0           stage4_unit1_relu2[0][0]
__________________________________________________________________________________________________
stage4_unit1_conv2 (Conv2D)     (None, None, None, 5 2359296     zero_padding2d_30[0][0]
__________________________________________________________________________________________________
stage4_unit1_sc (Conv2D)        (None, None, None, 5 131072      stage4_unit1_relu1[0][0]
__________________________________________________________________________________________________
add_14 (Add)                    (None, None, None, 5 0           stage4_unit1_conv2[0][0]
                                                                 stage4_unit1_sc[0][0]
__________________________________________________________________________________________________
stage4_unit2_bn1 (BatchNormaliz (None, None, None, 5 2048        add_14[0][0]
__________________________________________________________________________________________________
stage4_unit2_relu1 (Activation) (None, None, None, 5 0           stage4_unit2_bn1[0][0]
__________________________________________________________________________________________________
zero_padding2d_31 (ZeroPadding2 (None, None, None, 5 0           stage4_unit2_relu1[0][0]
__________________________________________________________________________________________________
stage4_unit2_conv1 (Conv2D)     (None, None, None, 5 2359296     zero_padding2d_31[0][0]
__________________________________________________________________________________________________
stage4_unit2_bn2 (BatchNormaliz (None, None, None, 5 2048        stage4_unit2_conv1[0][0]
__________________________________________________________________________________________________
stage4_unit2_relu2 (Activation) (None, None, None, 5 0           stage4_unit2_bn2[0][0]
__________________________________________________________________________________________________
zero_padding2d_32 (ZeroPadding2 (None, None, None, 5 0           stage4_unit2_relu2[0][0]
__________________________________________________________________________________________________
stage4_unit2_conv2 (Conv2D)     (None, None, None, 5 2359296     zero_padding2d_32[0][0]
__________________________________________________________________________________________________
add_15 (Add)                    (None, None, None, 5 0           stage4_unit2_conv2[0][0]
                                                                 add_14[0][0]
__________________________________________________________________________________________________
stage4_unit3_bn1 (BatchNormaliz (None, None, None, 5 2048        add_15[0][0]
__________________________________________________________________________________________________
stage4_unit3_relu1 (Activation) (None, None, None, 5 0           stage4_unit3_bn1[0][0]
__________________________________________________________________________________________________
zero_padding2d_33 (ZeroPadding2 (None, None, None, 5 0           stage4_unit3_relu1[0][0]
__________________________________________________________________________________________________
stage4_unit3_conv1 (Conv2D)     (None, None, None, 5 2359296     zero_padding2d_33[0][0]
__________________________________________________________________________________________________
stage4_unit3_bn2 (BatchNormaliz (None, None, None, 5 2048        stage4_unit3_conv1[0][0]
__________________________________________________________________________________________________
stage4_unit3_relu2 (Activation) (None, None, None, 5 0           stage4_unit3_bn2[0][0]
__________________________________________________________________________________________________
zero_padding2d_34 (ZeroPadding2 (None, None, None, 5 0           stage4_unit3_relu2[0][0]
__________________________________________________________________________________________________
stage4_unit3_conv2 (Conv2D)     (None, None, None, 5 2359296     zero_padding2d_34[0][0]
__________________________________________________________________________________________________
add_16 (Add)                    (None, None, None, 5 0           stage4_unit3_conv2[0][0]
                                                                 add_15[0][0]
__________________________________________________________________________________________________
bn1 (BatchNormalization)        (None, None, None, 5 2048        add_16[0][0]
__________________________________________________________________________________________________
relu1 (Activation)              (None, None, None, 5 0           bn1[0][0]
__________________________________________________________________________________________________
decoder_stage0_upsampling (UpSa (None, None, None, 5 0           relu1[0][0]
__________________________________________________________________________________________________
decoder_stage0_concat (Concaten (None, None, None, 7 0           decoder_stage0_upsampling[0][0]
                                                                 stage4_unit1_relu1[0][0]
__________________________________________________________________________________________________
decoder_stage0a_conv (Conv2D)   (None, None, None, 2 1769472     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, 3 0           decoder_stage1_upsampling[0][0]
                                                                 stage3_unit1_relu1[0][0]
__________________________________________________________________________________________________
decoder_stage1a_conv (Conv2D)   (None, None, None, 1 442368      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, 1 0           decoder_stage2_upsampling[0][0]
                                                                 stage2_unit1_relu1[0][0]
__________________________________________________________________________________________________
decoder_stage2a_conv (Conv2D)   (None, None, None, 6 110592      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, 1 0           decoder_stage3_upsampling[0][0]
                                                                 relu0[0][0]
__________________________________________________________________________________________________
decoder_stage3a_conv (Conv2D)   (None, None, None, 3 36864       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 (Activatio (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 (Activatio (None, None, None, 1 0           decoder_stage4b_bn[0][0]
__________________________________________________________________________________________________
final_conv (Conv2D)             (None, None, None, 2 3045        decoder_stage4b_relu[0][0]
__________________________________________________________________________________________________
softmax (Activation)            (None, None, None, 2 0           final_conv[0][0]
==================================================================================================
Total params: 24,459,054
Trainable params: 24,441,704
Non-trainable params: 17,350
__________________________________________________________________________________________________
```

In [ ]:

```
# import imgaug.augmenters as iaa
# For the assignment choose any 4 augumentation techniques
# check the imgaug documentations for more augmentations
aug2 = iaa.Fliplr(1)
aug3 = iaa.Flipud(1)
aug4 = iaa.Emboss(alpha=(1), strength=1)
aug5 = iaa.DirectedEdgeDetect(alpha=(0.8), direction=(1.0))
aug6 = iaa.Sharpen(alpha=(1.0), lightness=(1.5))
```

In [ ]:

```

def normalize_image(mask):
    mask = mask/255
    return mask

class Dataset:
    # we will be modifying this CLASSES according to your data/problems
    # CLASSES = list(label_clr.values())

    # the parameters needs to changed based on your requirements
    # here we are collecting the file_names because in our dataset, both our images and maks will have same file name
    # ex: fil_name.jpg   file_name.mask.jpg
    def __init__(self, image_dir, mask_dir):

        # the paths of images
        self.images_fps = image_dir
        # the paths of segmentation images
        self.masks_fps = mask_dir
        # giving labels for each class
        self.class_values = CLASSES

    def __getitem__(self, i):

        # read data
        image = cv2.imread(self.images_fps[i], )
        image = cv2.resize(image, (512, 512))
        mask  = cv2.imread(self.masks_fps[i], 0)
        mask = cv2.resize(mask, (512, 512))
        image_mask = mask
        # instead of image_mask -> we do not normalize normalise(mask)


        image_masks = [(image_mask == v) for v in self.class_values]
        image_mask = np.stack(image_masks, axis=-1).astype('int')

        """a = np.random.uniform()
        if a<0.2:
            image = aug2.augment_image(image)
            image_mask = aug2.augment_image(image_mask)
        elif a<0.4:
            image = aug3.augment_image(image)
            image_mask = aug3.augment_image(image_mask)
        elif a<0.6:
            image = aug4.augment_image(image)
            image_mask = aug4.augment_image(image_mask)
        elif a<0.8:
            image = aug5.augment_image(image)
            image_mask = aug5.augment_image(image_mask)
        else:
            image = aug6.augment_image(image)
            image_mask = aug6.augment_image(image_mask)
        """
        return image, image_mask

    def __len__(self):
        return len(self.images_fps)


class Dataloder(tf.keras.utils.Sequence):
    def __init__(self, dataset, batch_size=1, shuffle=False):
        self.dataset = dataset
        self.batch_size = batch_size
        self.shuffle = shuffle
        self.indexes = np.arange(len(dataset))

    def __getitem__(self, i):

        # collect batch data
        start = i * self.batch_size
        stop = (i + 1) * self.batch_size
        data = []
        for j in range(start, stop):
            data.append(self.dataset[j])

        batch = [np.stack(samples, axis=0) for samples in zip(*data)]

        return tuple(batch)

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

    def on_epoch_end(self):
        if self.shuffle:
            self.indexes = np.random.permutation(self.indexes)
```

In [ ]:

```
# Dataset for train images
CLASSES = list(new_label_clr.values())
train_dataset = Dataset(list(X_train['image']),list(X_train['mask']))
test_dataset  = Dataset(list(X_test['image']),list(X_test['mask']))
```

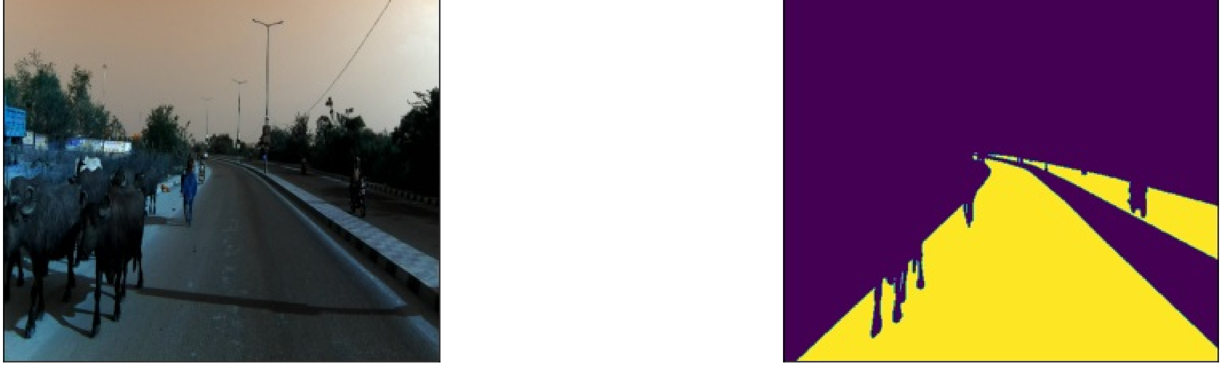
In [ ]:

```
def visualize(images):
    n = len(images)
    plt.figure(figsize=(16, 5))
    for i, (name, image) in enumerate(images.items()):
        plt.subplot(1, n, i + 1)
        plt.xticks([])
        plt.yticks([])
        plt.title(' '.join(name.split('_')).title())
        if i==1:
            plt.imshow(image,  vmax=1, vmin=0)
        else:
            plt.imshow(image)
    plt.show()
```

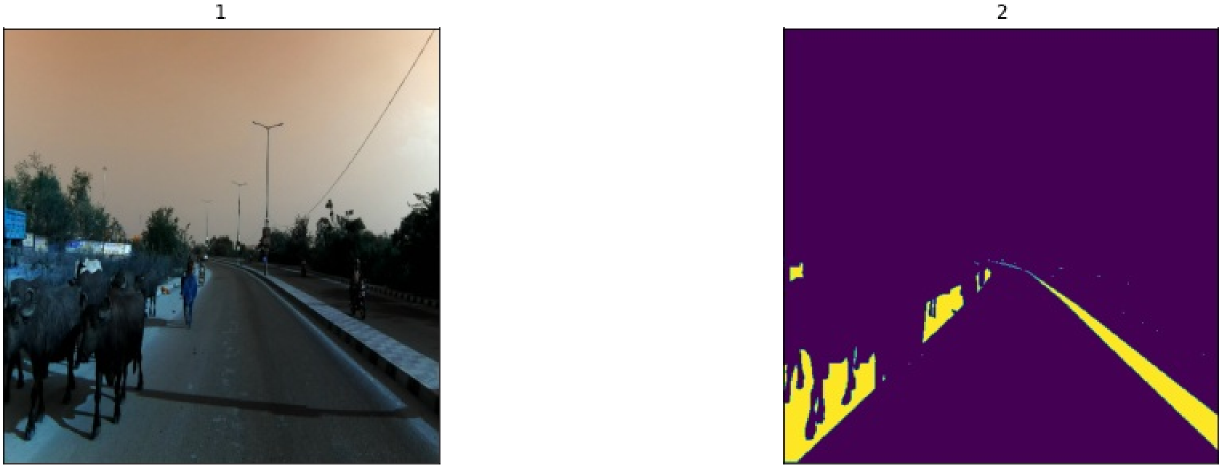
In [ ]:

```
idx = 3
for i in range(len(CLASSES)):
  print(list(new_label_clr.keys())[i])
  visualize({'1': train_dataset[idx][0], '2': train_dataset[idx][1][:,:,i]})
  plt.show()
```

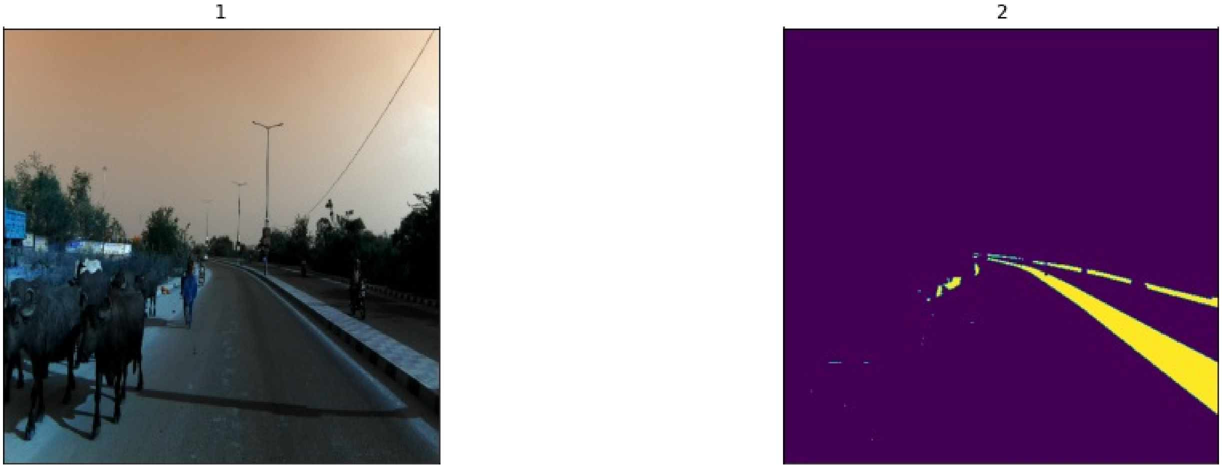
```
road
```



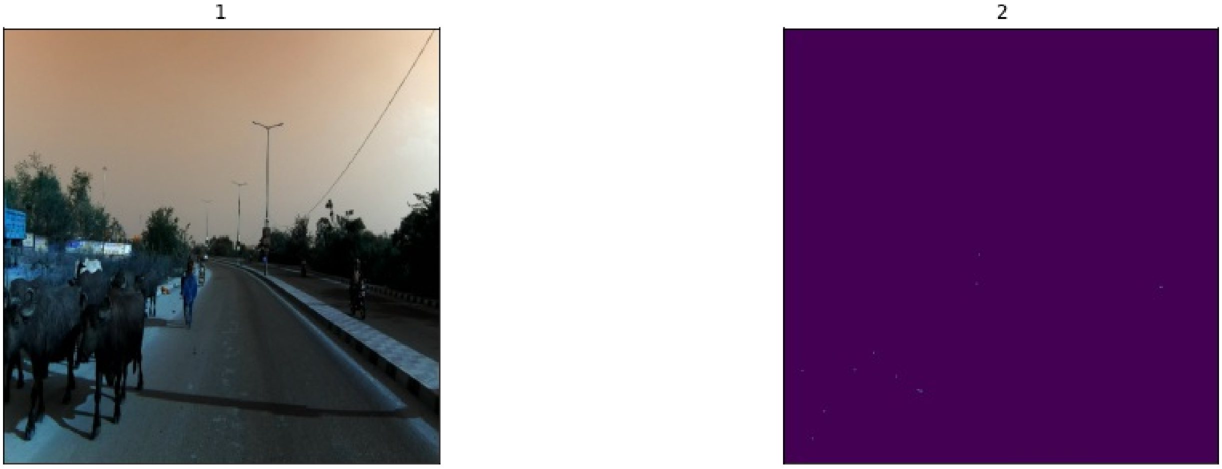
parking / drivable fallback



sidewalk

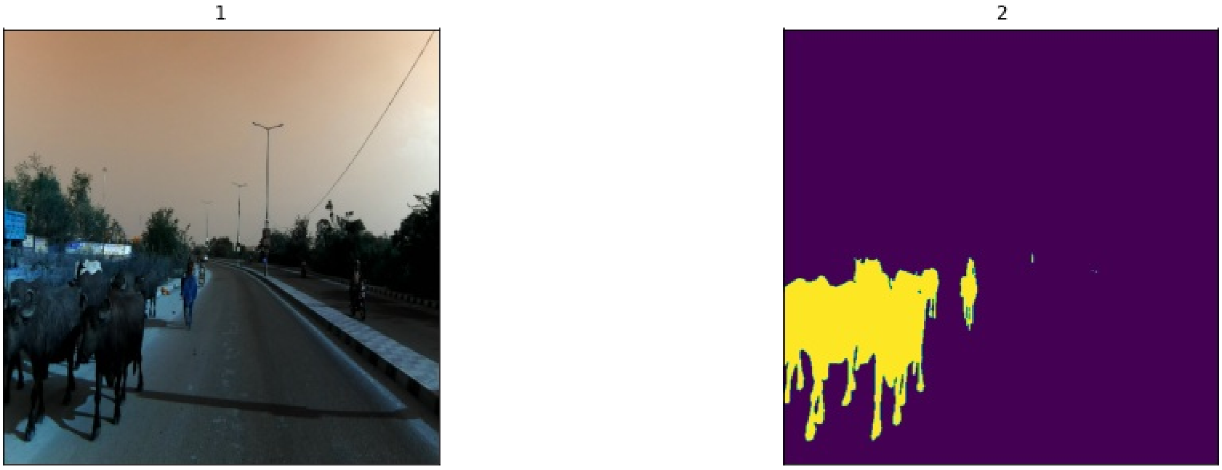


non-drivable fallback / rail track

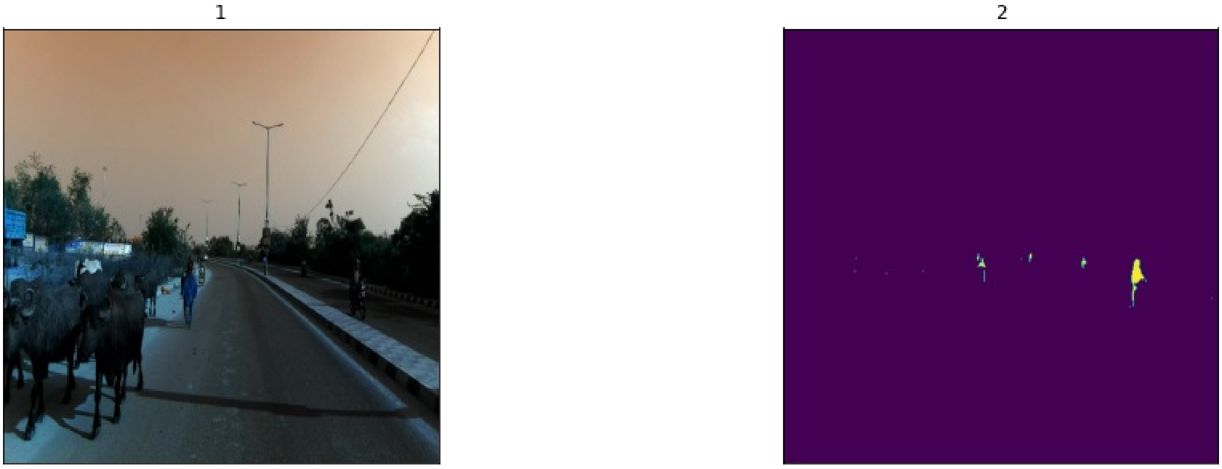


person / animal

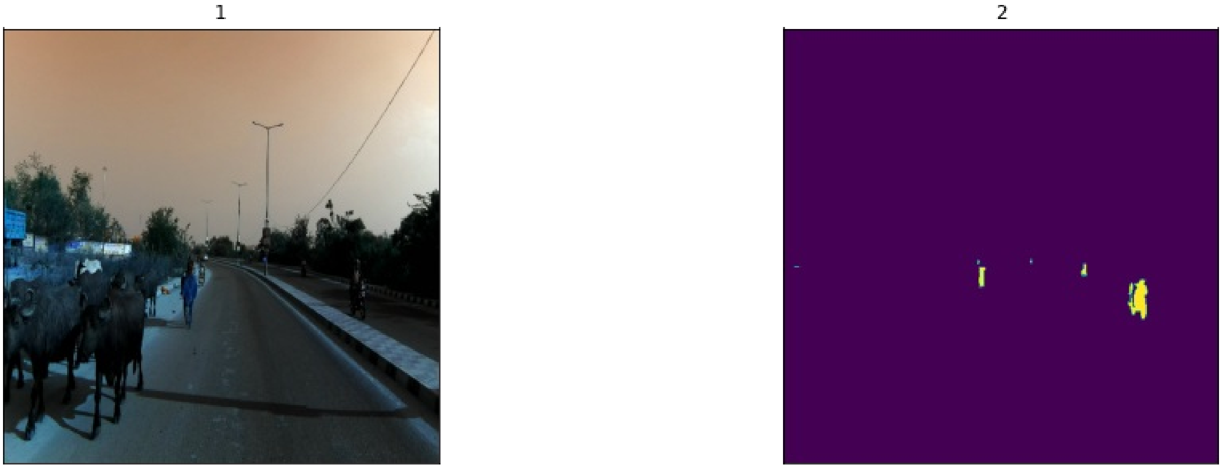
person / animal



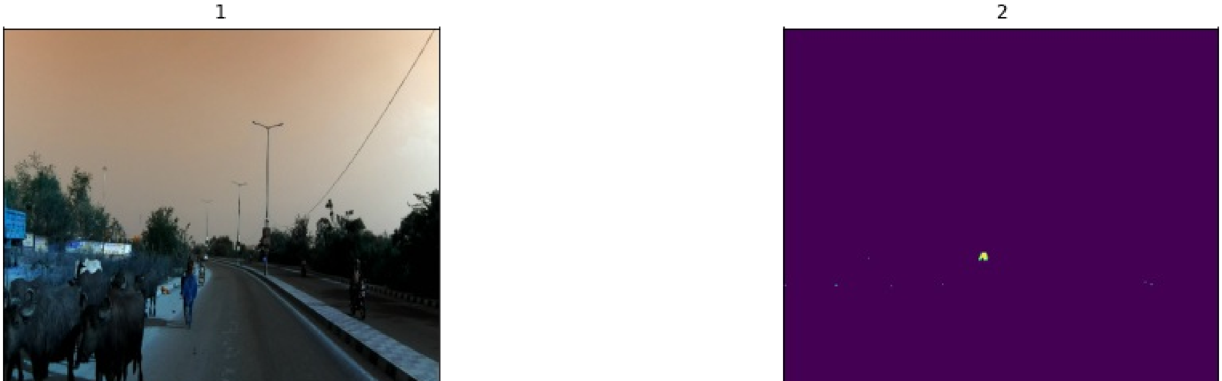
rider



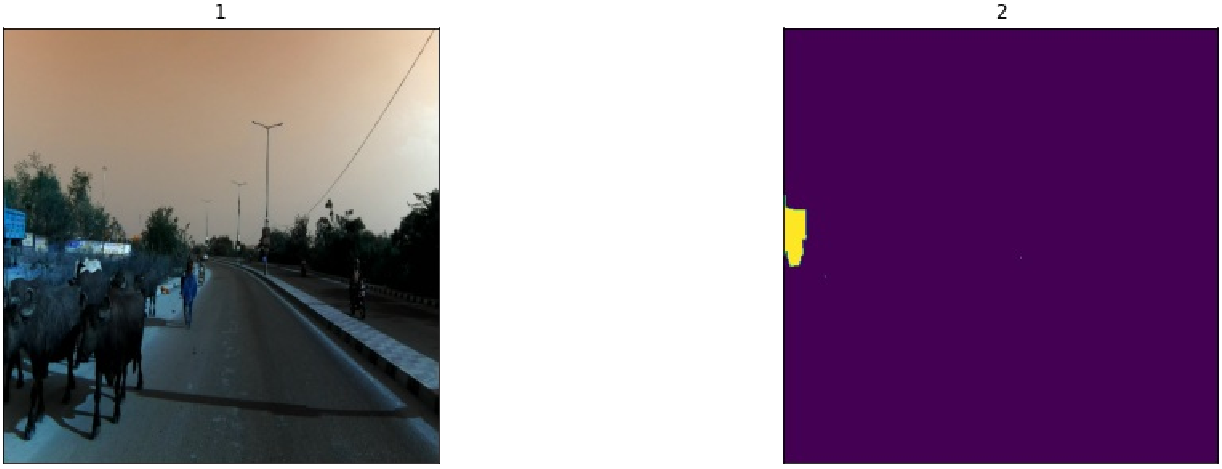
motorcycle / bicycle



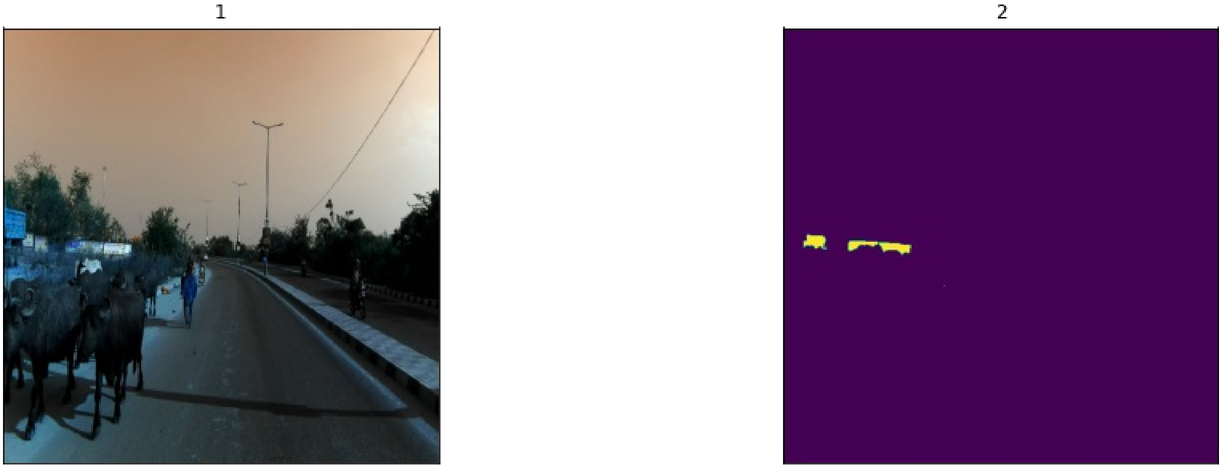
autorickshaw / car



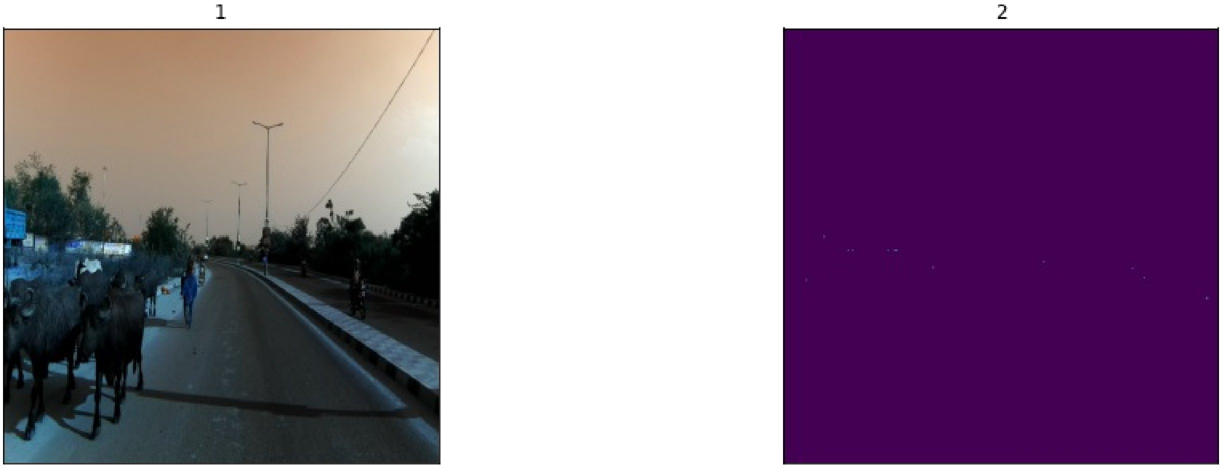
truck / bus / vehicle fallback / trailer / caravan



curb / wall

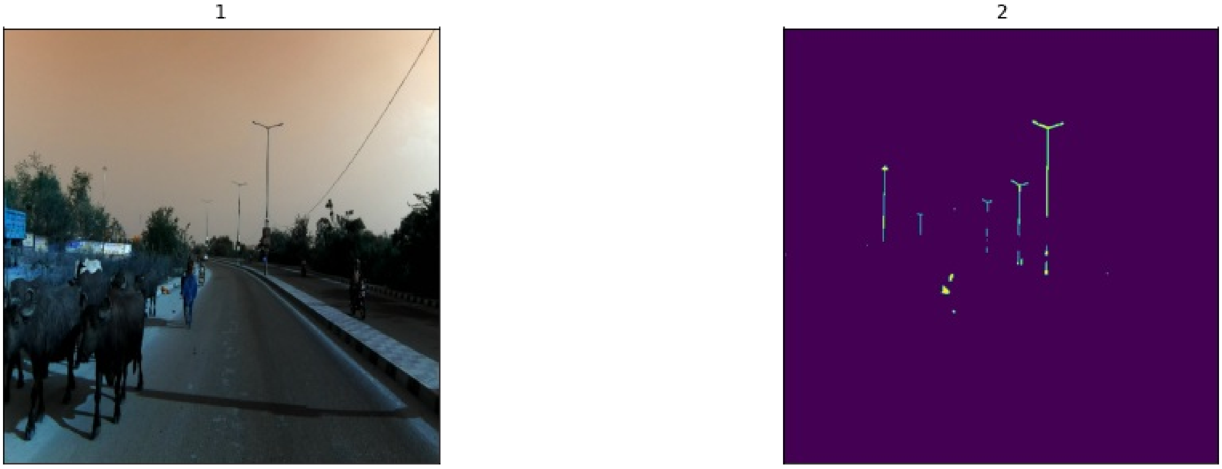


fence / guard rail

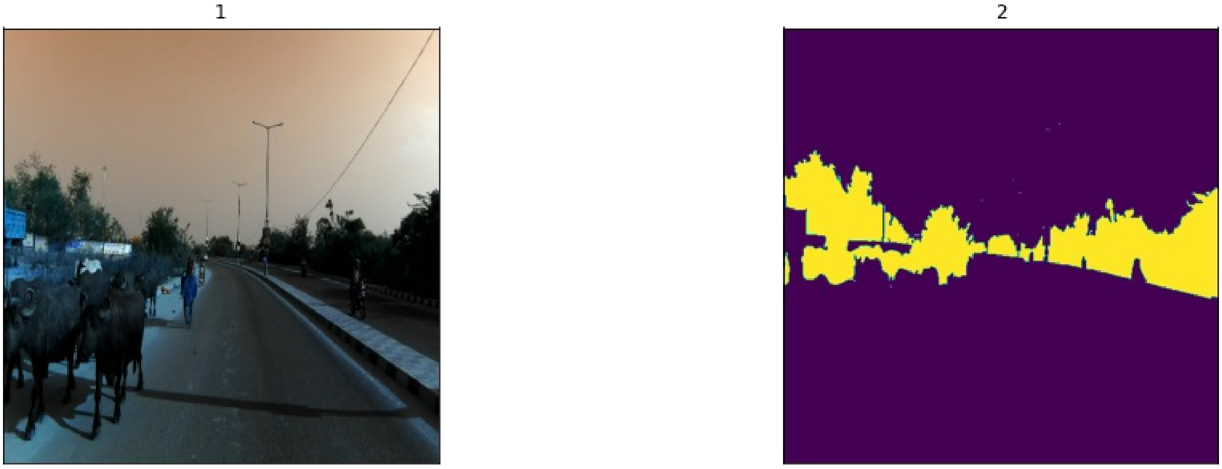


billboard / traffic sign / traffic light

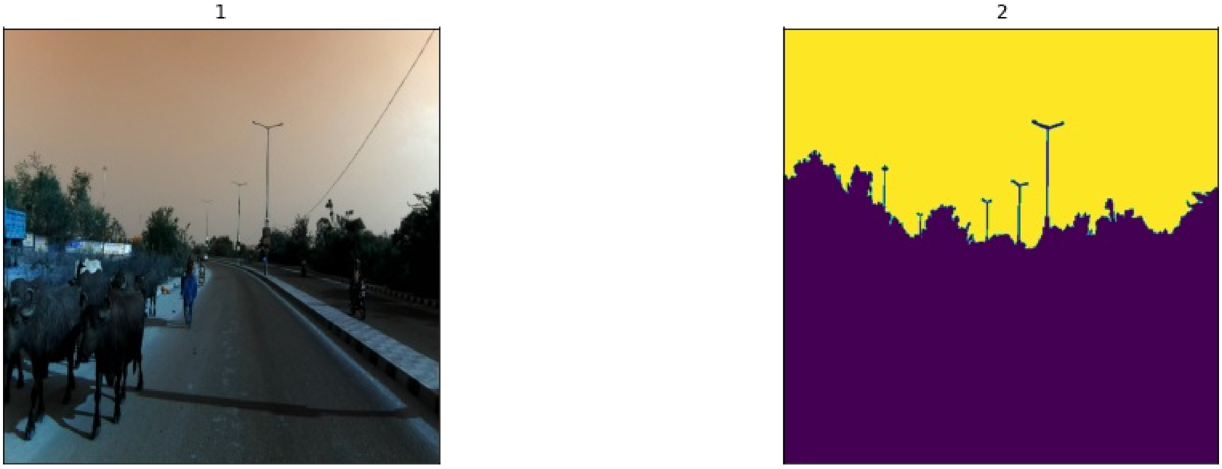
pole / polegroup / obs-str-bar-fallback



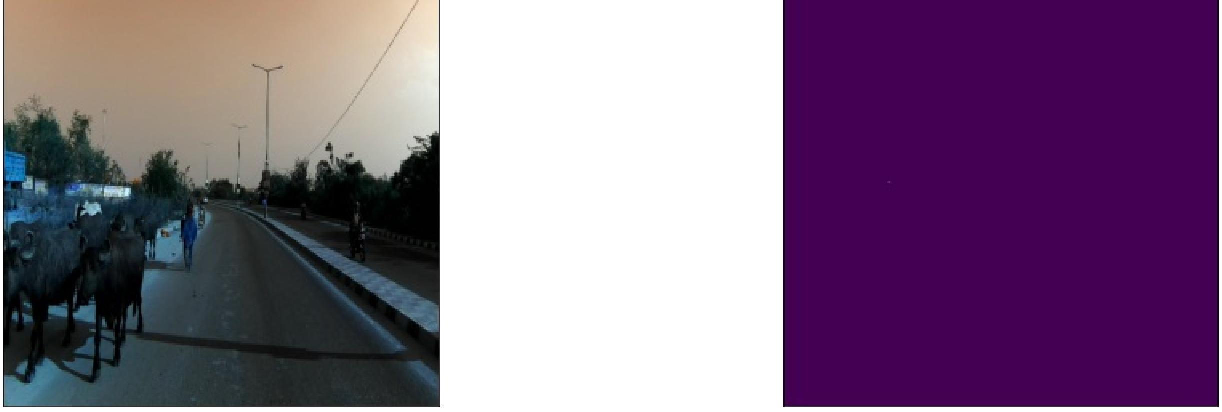
vegetation



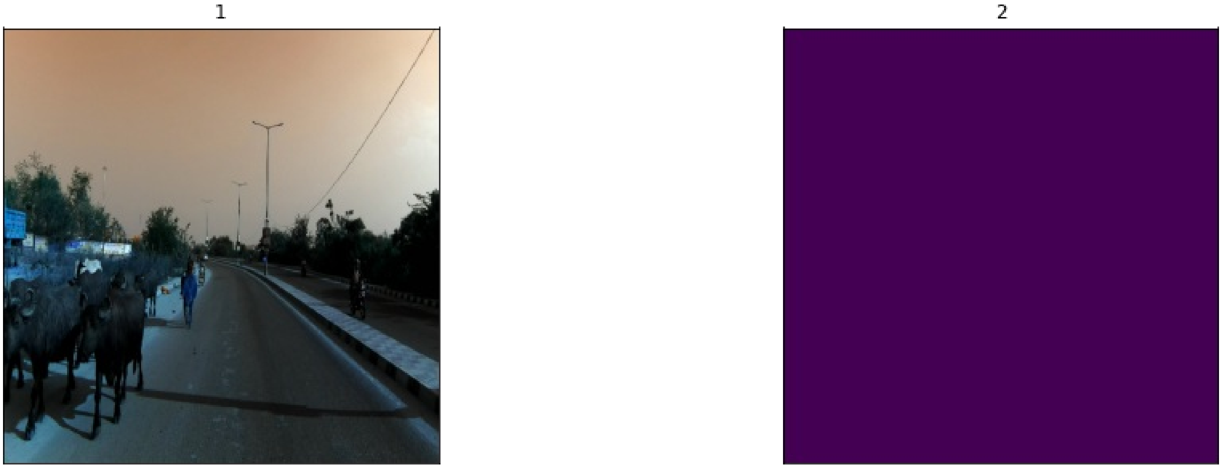
sky / fallback background



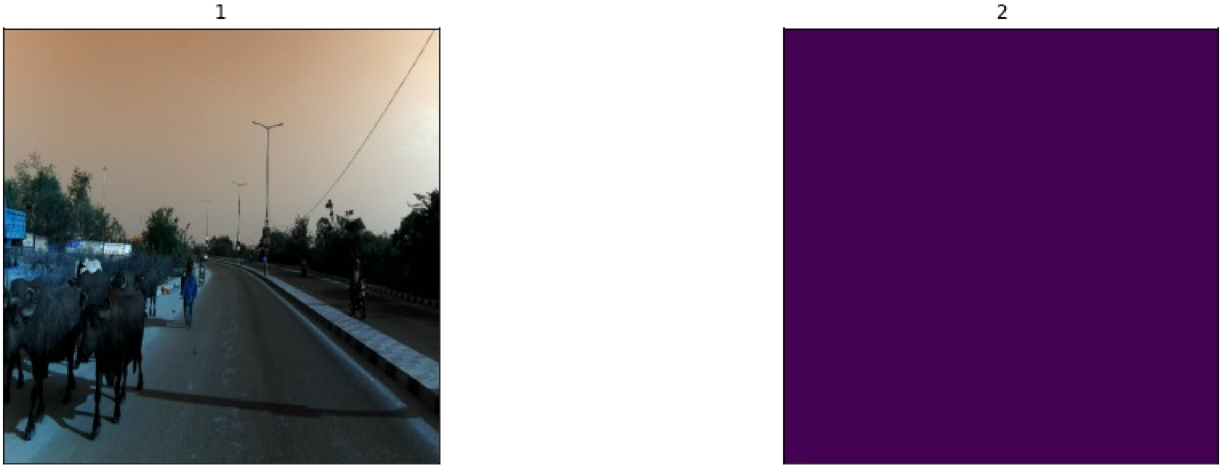
unlabeled / out of roi



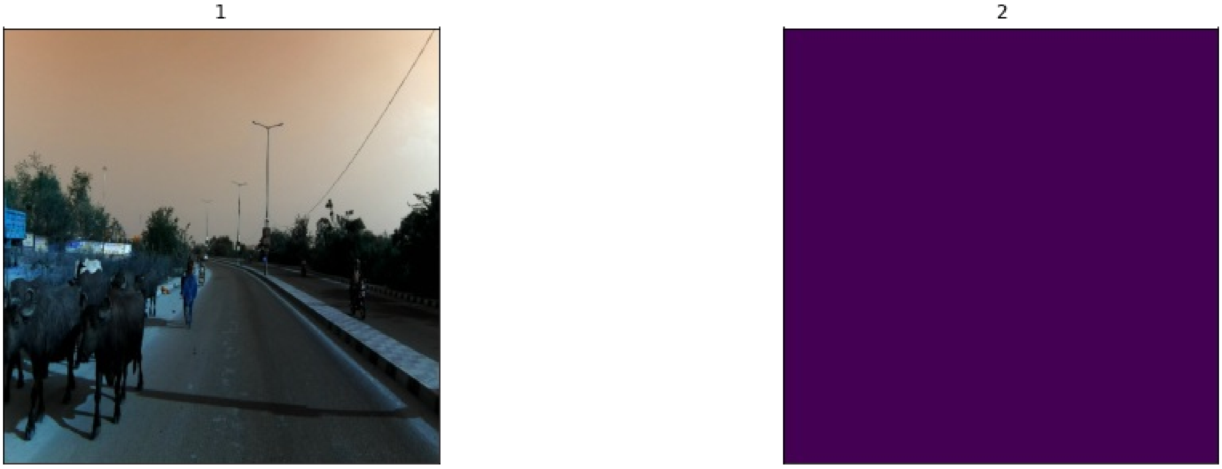
ego vehicle



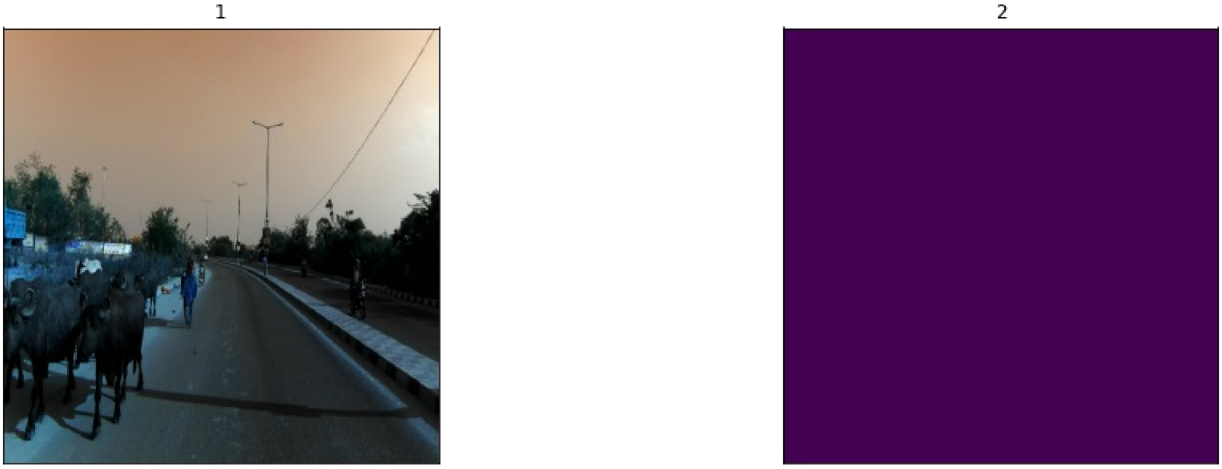
ground



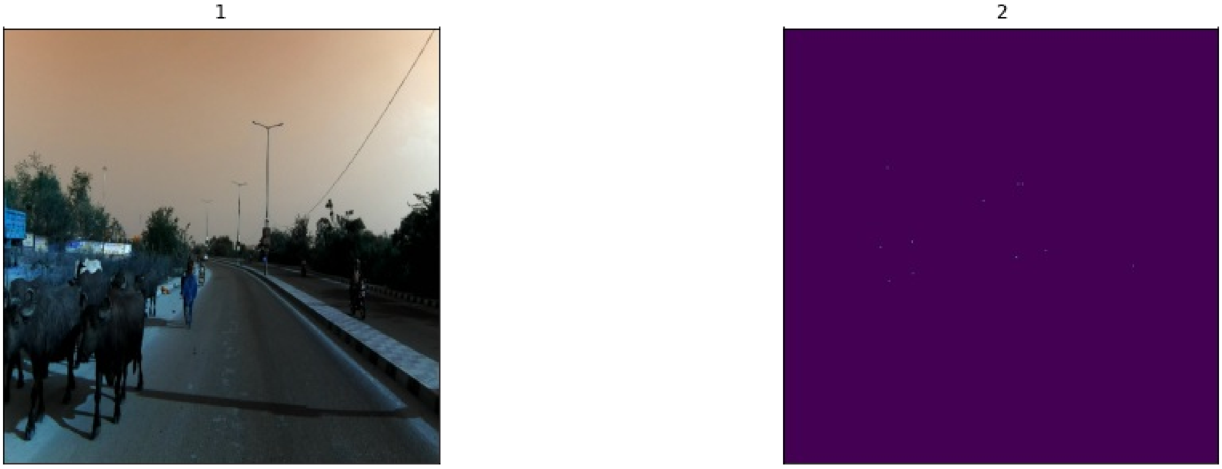
rectification border



train



building / bridge / tunnel



In [ ]:

```
BATCH_SIZE = 4
train_dataloader = Dataloder(train_dataset, batch_size= BATCH_SIZE, shuffle=True)
test_dataloader = Dataloder(test_dataset, batch_size= BATCH_SIZE, shuffle=True)

print(train_dataloader[0][0].shape)
print(train_dataloader[0][1].shape)

assert train_dataloader[0][0].shape == (BATCH_SIZE, 512, 512, 3)
assert train_dataloader[0][1].shape == (BATCH_SIZE, 512, 512, 21)
```

```
(4, 512, 512, 3)
(4, 512, 512, 21)
```

In [ ]:

```
# https://datascience.stackexchange.com/a/45166/75326
from keras import backend as K

def recall_k(y_true, y_pred):
    true_positives = K.sum(K.round(K.clip(y_true * y_pred, 0, 1)))
    actual_positives = K.sum(K.round(K.clip(y_true, 0, 1)))
    recall = true_positives / (actual_positives + K.epsilon())
    return recall

def precision_k(y_true, y_pred):
    true_positives = K.sum(K.round(K.clip(y_true * y_pred, 0, 1)))
    predicted_positives = K.sum(K.round(K.clip(y_pred, 0, 1)))
    precision = true_positives / (predicted_positives + K.epsilon())
    return precision

def f1_keras(y_true, y_pred):
    precision = precision_k(y_true, y_pred)
    recall = recall_k(y_true, y_pred)
    return 2*((precision*recall)/(precision+recall+K.epsilon()))
    return 2 ((precision recall)/(precision+recall+K.epsilon()))
```

In [ ]:

```
optim = tf.keras.optimizers.Adam()

focal_loss = sm.losses.cce_dice_loss

# actulally total_loss can be imported directly from library, above example just show you how to manipulate with losses
# total_loss = sm.losses.binary_focal_dice_loss
# or total_loss = sm.losses.categorical_focal_dice_loss

model.compile(optim, focal_loss, metrics=[sm.metrics.IOUScore(threshold = 0.5), f1_keras])
```

In [ ]:

```
history = model.fit_generator(train_dataloader, steps_per_epoch=len(train_dataloader), epochs= 20, \
                    validation_data=test_dataloader,)
```

```
Epoch 1/20
902/902 [==============================] - 699s 775ms/step - loss: 0.7827 - iou_score: 0.4034 - f1_keras: 0.7554 - val_loss: 0.6763 - val_io
u_score: 0.4485 - val_f1_keras: 0.7792
Epoch 2/20
902/902 [==============================] - 676s 750ms/step - loss: 0.6785 - iou_score: 0.4825 - f1_keras: 0.8013 - val_loss: 0.6451 - val_io
u_score: 0.5025 - val_f1_keras: 0.8176
Epoch 3/20
902/902 [==============================] - 684s 758ms/step - loss: 0.6389 - iou_score: 0.5146 - f1_keras: 0.8212 - val_loss: 0.7314 - val_io
u_score: 0.4195 - val_f1_keras: 0.7171
Epoch 4/20
902/902 [==============================] - 683s 758ms/step - loss: 0.6140 - iou_score: 0.5353 - f1_keras: 0.8331 - val_loss: 0.6095 - val_io
u_score: 0.4996 - val_f1_keras: 0.8113
Epoch 5/20
902/902 [==============================] - 684s 759ms/step - loss: 0.5967 - iou_score: 0.5502 - f1_keras: 0.8420 - val_loss: 0.6138 - val_io
u_score: 0.5073 - val_f1_keras: 0.7912
Epoch 6/20
902/902 [==============================] - 684s 758ms/step - loss: 0.4699 - iou_score: 0.5616 - f1_keras: 0.8482 - val_loss: 0.4226 - val_io
u_score: 0.5480 - val_f1_keras: 0.8439
Epoch 7/20
902/902 [==============================] - 685s 759ms/step - loss: 0.4296 - iou_score: 0.5721 - f1_keras: 0.8542 - val_loss: 0.4440 - val_io
u_score: 0.5402 - val_f1_keras: 0.8372
Epoch 8/20
902/902 [==============================] - 685s 759ms/step - loss: 0.4180 - iou_score: 0.5826 - f1_keras: 0.8594 - val_loss: 0.3846 - val_io
u_score: 0.5683 - val_f1_keras: 0.8583
Epoch 9/20
902/902 [==============================] - 686s 760ms/step - loss: 0.4107 - iou_score: 0.5889 - f1_keras: 0.8638 - val_loss: 0.3730 - val_io
u_score: 0.5706 - val_f1_keras: 0.8603
Epoch 10/20
902/902 [==============================] - 686s 760ms/step - loss: 0.4023 - iou_score: 0.5967 - f1_keras: 0.8673 - val_loss: 0.3920 - val_io
u_score: 0.5687 - val_f1_keras: 0.8535
Epoch 11/20
902/902 [==============================] - 686s 760ms/step - loss: 0.3925 - iou_score: 0.6056 - f1_keras: 0.8722 - val_loss: 0.3762 - val_io
u_score: 0.5773 - val_f1_keras: 0.8608
Epoch 12/20
902/902 [==============================] - 679s 753ms/step - loss: 0.3911 - iou_score: 0.6069 - f1_keras: 0.8729 - val_loss: 0.3863 - val_io
u_score: 0.5745 - val_f1_keras: 0.8567
Epoch 13/20
902/902 [==============================] - 677s 751ms/step - loss: 0.3812 - iou_score: 0.6160 - f1_keras: 0.8779 - val_loss: 0.3563 - val_io
u_score: 0.5889 - val_f1_keras: 0.8664
Epoch 14/20
902/902 [==============================] - 678s 751ms/step - loss: 0.3779 - iou_score: 0.6192 - f1_keras: 0.8795 - val_loss: 0.3796 - val_io
u_score: 0.5854 - val_f1_keras: 0.8647
Epoch 15/20
902/902 [==============================] - 677s 751ms/step - loss: 0.3708 - iou_score: 0.6256 - f1_keras: 0.8828 - val_loss: 0.3636 - val_io
u_score: 0.5894 - val_f1_keras: 0.8707
Epoch 16/20
902/902 [==============================] - 679s 753ms/step - loss: 0.3614 - iou_score: 0.6347 - f1_keras: 0.8875 - val_loss: 0.3639 - val_io
u_score: 0.5967 - val_f1_keras: 0.8657
Epoch 17/20
902/902 [==============================] - 678s 751ms/step - loss: 0.3619 - iou_score: 0.6342 - f1_keras: 0.8872 - val_loss: 0.3537 - val_io
u_score: 0.5931 - val_f1_keras: 0.8731
Epoch 18/20
902/902 [==============================] - 678s 751ms/step - loss: 0.3586 - iou_score: 0.6373 - f1_keras: 0.8889 - val_loss: 0.3637 - val_io
u_score: 0.5917 - val_f1_keras: 0.8755
Epoch 19/20
902/902 [==============================] - 678s 752ms/step - loss: 0.3507 - iou_score: 0.6449 - f1_keras: 0.8931 - val_loss: 0.3829 - val_io
u_score: 0.6026 - val_f1_keras: 0.8783
Epoch 20/20
902/902 [==============================] - 678s 752ms/step - loss: 0.3473 - iou_score: 0.6484 - f1_keras: 0.8940 - val_loss: 0.3679 - val_io
u_score: 0.5994 - val_f1_keras: 0.8680
```

In [ ]:

```
model.save('/content/drive/My Drive/model.h5', include_optimizer= False)

model1 = tf.keras.models.load_model('/content/drive/My Drive/model.h5')

optim = tf.keras.optimizers.Adam()

model1.compile(optim, focal_loss, metrics=[sm.metrics.IOUScore(threshold = 0.5), f1_keras])

history1 = model1.fit_generator(train_dataloader, steps_per_epoch=len(train_dataloader), epochs= 10, \
                       validation_data=test_dataloader,)
```

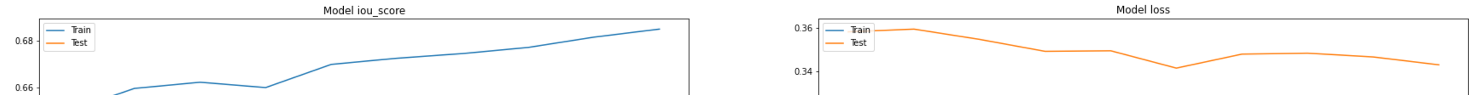
```
WARNING:tensorflow:No training configuration found in the save file, so the model was *not* compiled. Compile it manually.
WARNING:tensorflow:From <ipython-input-58-e9c817b3f422>:10: Model.fit_generator (from tensorflow.python.keras.engine.training) is deprecated a
nd will be removed in a future version.
Instructions for updating:
Please use Model.fit, which supports generators.
Epoch 1/10
902/902 [==============================] - 472s 524ms/step - loss: 0.3076 - iou_score: 0.6498 - f1_keras: 0.8956 - val_loss: 0.3582 - val_io
u_score: 0.5949 - val_f1_keras: 0.8760
Epoch 2/10
902/902 [==============================] - 471s 522ms/step - loss: 0.2884 - iou_score: 0.6595 - f1_keras: 0.9007 - val_loss: 0.3594 - val_io
u_score: 0.5960 - val_f1_keras: 0.8758
Epoch 3/10
902/902 [==============================] - 471s 522ms/step - loss: 0.2857 - iou_score: 0.6621 - f1_keras: 0.9019 - val_loss: 0.3547 - val_io
u_score: 0.5987 - val_f1_keras: 0.8793
Epoch 4/10
902/902 [==============================] - 472s 523ms/step - loss: 0.2875 - iou_score: 0.6599 - f1_keras: 0.9013 - val_loss: 0.3492 - val_io
u_score: 0.6030 - val_f1_keras: 0.8757
Epoch 5/10
902/902 [==============================] - 471s 522ms/step - loss: 0.2778 - iou_score: 0.6698 - f1_keras: 0.9063 - val_loss: 0.3495 - val_io
u_score: 0.6039 - val_f1_keras: 0.8811
Epoch 6/10
902/902 [==============================] - 472s 523ms/step - loss: 0.2752 - iou_score: 0.6724 - f1_keras: 0.9074 - val_loss: 0.3415 - val_io
u_score: 0.6103 - val_f1_keras: 0.8819
Epoch 7/10
902/902 [==============================] - 470s 521ms/step - loss: 0.2732 - iou_score: 0.6744 - f1_keras: 0.9090 - val_loss: 0.3479 - val_io
u_score: 0.6055 - val_f1_keras: 0.8799
Epoch 8/10
902/902 [==============================] - 471s 522ms/step - loss: 0.2705 - iou_score: 0.6770 - f1_keras: 0.9098 - val_loss: 0.3484 - val_io
u_score: 0.6050 - val_f1_keras: 0.8794
Epoch 9/10
902/902 [==============================] - 470s 521ms/step - loss: 0.2662 - iou_score: 0.6814 - f1_keras: 0.9120 - val_loss: 0.3467 - val_io
u_score: 0.6074 - val_f1_keras: 0.8830
Epoch 10/10
902/902 [==============================] - 471s 522ms/step - loss: 0.2629 - iou_score: 0.6849 - f1_keras: 0.9133 - val_loss: 0.3430 - val_io
u_score: 0.6116 - val_f1_keras: 0.8812
```

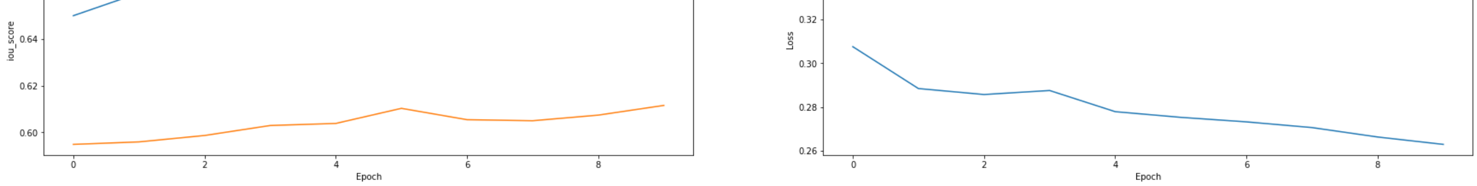
In [ ]:

```
model1.save('/content/drive/My Drive/model1.h5', include_optimizer= False)
```

In [ ]:

```
# Plot training & validation iou_score values
plt.figure(figsize=(30, 5))
plt.subplot(121)
plt.plot(history1.history['iou_score'])
plt.plot(history1.history['val_iou_score'])
plt.title('Model iou_score')
plt.ylabel('iou_score')
plt.xlabel('Epoch')
plt.legend(['Train', 'Test'], loc='upper left')

# Plot training & validation loss values
plt.subplot(122)
plt.plot(history1.history['loss'])
plt.plot(history1.history['val_loss'])
plt.title('Model loss')
plt.ylabel('Loss')
plt.xlabel('Epoch')
plt.legend(['Train', 'Test'], loc='upper left')
plt.show()
```





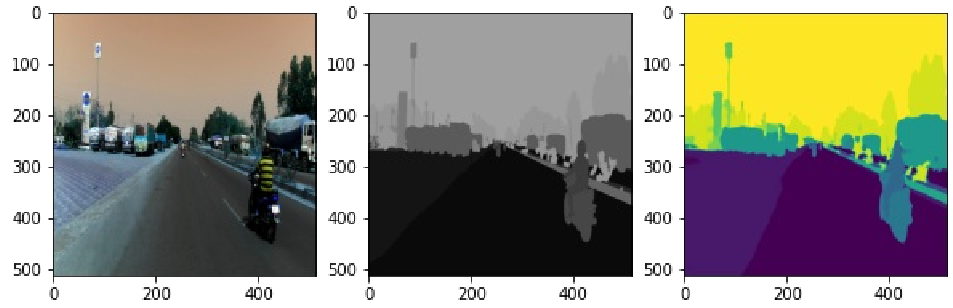
In [ ]:

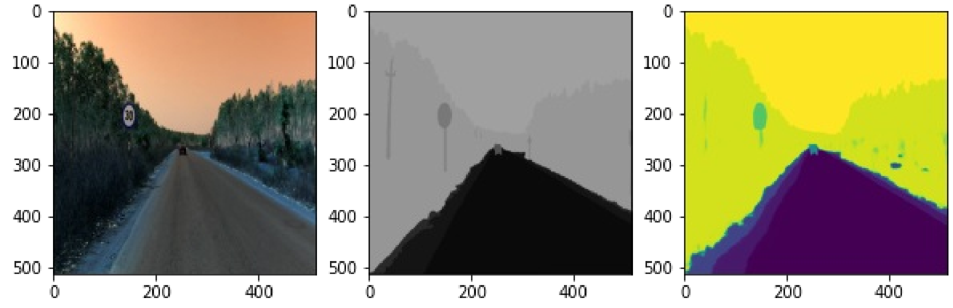
```
model2 = tf.keras.models.load_model('/content/drive/My Drive/model1.h5')
```

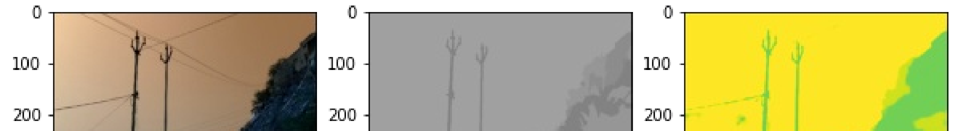
```
WARNING:tensorflow:No training configuration found in the save file, so the model was *not* compiled. Compile it manually.
```

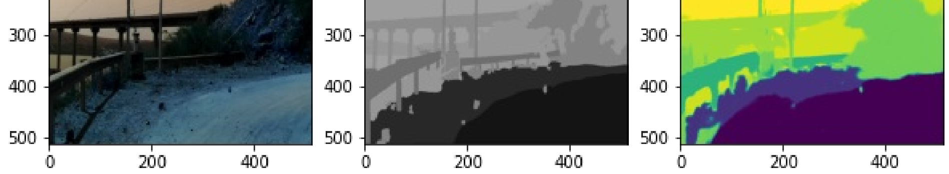
In [ ]:

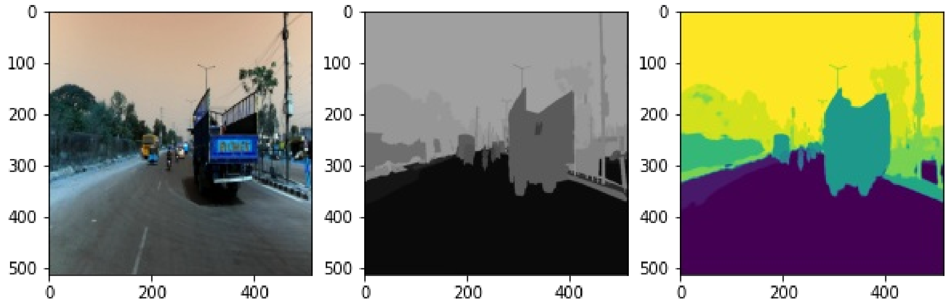
```
# https://www.geeksforgeeks.org/iterating-over-rows-and-columns-in-pandas-dataframe/

img = X_test['image'][40:45]
mas = X_test['mask'][40:45]

for i, j in zip(img, mas):
   #original image
   image = cv2.imread(i, )
   image = cv2.resize(image, (512,512), )

   #predicted segmentation map
   predicted  = model2.predict(image[np.newaxis,:,:,:])
   predicted.shape

   #original segmentation map
   image_mask = cv2.imread(j)
   image_mask = cv2.resize(image_mask, (512,512))

   plt.figure(figsize=(10,6))
   plt.subplot(131)
   plt.imshow(image)
   plt.subplot(132)
   plt.imshow(image_mask)
   plt.subplot(133)

   z = np.zeros(shape = (512, 512), dtype = 'float32')
   for i in range(len(new_label_clr.values())):
     z += (predicted[0][:, :, i] * list(new_label_clr.values())[i])

   plt.imshow(z)
   plt.show()
```

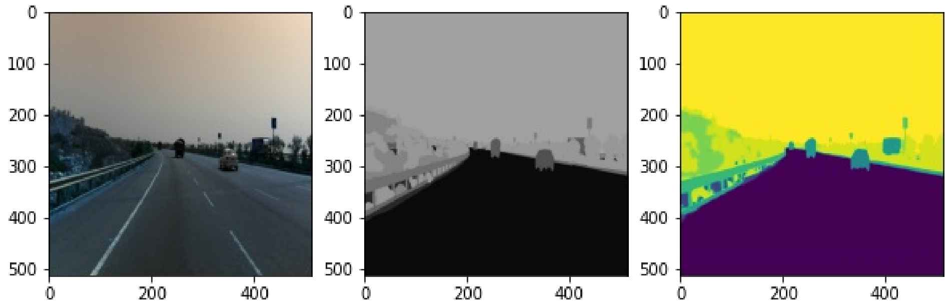












Observations

- The dataset we have used has around 4008 images of HD resolution (1080 * 1980) which are the pictures taken on various kinds of places mostly Traffic on roads in and around Hyderabad and Bengaluru.
- We have the coordinates and through which we have created polygons wherein these polygons are drawn onto a RGB image canvas but in 0 axis and hence we get a channels of 40, as we have 40 different classes.
- After the polygons are drawn we get y labelled images which are masked images of original and we use these in training to predict.
- As the classes are 40 and we need to color code them between 0-255 and we squeeze these classes further to 21 so that results during prediction shall be better.
- We havent normalized the images and also we havent used any image augumentation techniques too as the predictions are not good but we have resized the images t0 (512, 512) and we can resize in multiples of 32 also as the U-NET accepts these image shapes only.
- We have used U-NET architechture as the shape of input image is same as shape of the output image.
- In U-NET we have used "resnet-34" as base model, as this gives us good results among other base models such as "resnet-50" or "VGG-16".
- We have used dice loss as loss and Adam as optimizer with default learning rates as the results are pretty good.
- This dice loss is a cce loss which is categorical cross entropy loss as this is multiclass classification.
- We train the model with two metrics such as F1 score and as well as IOU score, which is intersection over union also called as jaccared similarity.
- We ran for 30 epochs in all and the model was saved.
- The predictions are better as the loss is around 0.26 and val iou score is around 61.5 and train iou score is around 68.5.
- The model seems slightly overfit, but nonetheless the results are good as can viszualize.

In [ ]: