semantic-segment_tfkeras(Best)

March 6, 2023

[220]:
```
#Libraries------------------
import os
import random
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import warnings
import gc
from tqdm.notebook import trange, tqdm
from itertools import chain
from skimage.io import imread, imshow, concatenate_images
from skimage.transform import resize
from skimage.morphology import label
from sklearn.model_selection import train_test_split
import glob
import cv2
import tensorflow as tf
from tensorflow.keras.preprocessing.image import ImageDataGenerator,␣
 ↪array_to_img, img_to_array, load_img
from tensorflow.keras.layers import Conv2D, Input, MaxPooling2D, Dropout,␣
 ↪concatenate, UpSampling2D
from tensorflow.keras.models import load_model, Model
from tensorflow.keras.optimizers import Adam
from tensorflow.keras.callbacks import EarlyStopping, ModelCheckpoint,␣
 ↪ReduceLROnPlateau, TensorBoard
from tensorflow.keras import backend as K
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import (BatchNormalization, Conv2DTranspose,
                                     SeparableConv2D, MaxPooling2D, Activation,␣
 ↪Flatten, Dropout, Dense)
from tensorflow.keras.preprocessing.image import load_img, array_to_img,␣
 ↪img_to_array
from tensorflow.keras.models import Model
from tensorflow.keras.layers import Conv2D, LeakyReLU, BatchNormalization,␣
 ↪MaxPool2D,Conv2DTranspose, concatenate,Input
from tensorflow.keras.callbacks import CSVLogger
K.clear_session()
```

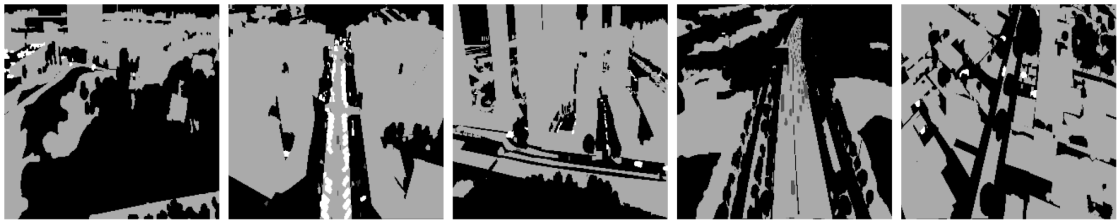
```
warnings.filterwarnings('ignore')
plt.style.use("ggplot")
%matplotlib inline
```

[221]:
```
#Load image data-------------------
w,h,ch=256,256,3
def load_img(path):
    img= cv2.imread(path)
    img= cv2.cvtColor(img, cv2.COLOR_BGR2RGB)
    img=cv2.resize(img,(w,h))
    return img
```

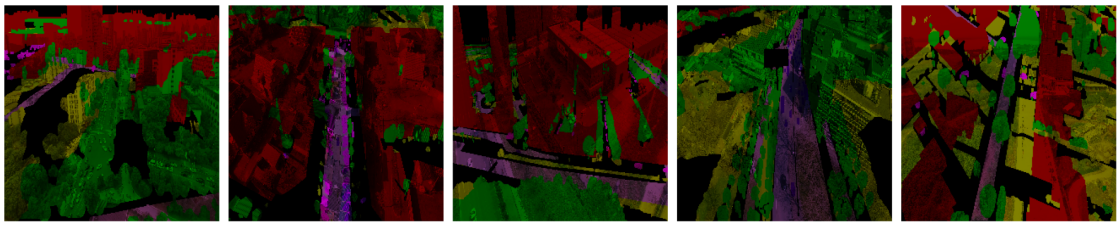
[222]:
```
#Load data---------------------
BASE_DIR="SegTMS/train/"
img_path= os.listdir(BASE_DIR+'Images')
mask_path= os.listdir(BASE_DIR+'Labels')
```

[224]:
```
#plot sample images--------------
fig, ax= plt.subplots(1,5, figsize=(20, 10))
for i in range(5):
    path= BASE_DIR + 'Images/'
    ax[i].imshow(load_img(path + img_path[i]))
    ax[i].set_xticks([]); ax[i].set_yticks([])

fig.tight_layout()
plt.show()
```

[225]:
```
#plot sample masks--------------
fig, ax= plt.subplots(1,5, figsize=(20, 10))
for i in range(5):
    path= BASE_DIR + 'Labels/'
    ax[i].imshow(load_img(path + mask_path[i])[:, :, 0], 'gray')
    ax[i].set_xticks([]); ax[i].set_yticks([])

fig.tight_layout()
plt.show()
```



[226]:
```
#plot sample images--with blended mask ------------
fig, ax= plt.subplots(1,5, figsize=(20, 10))
for i in range(5):
    path1= BASE_DIR + 'Images/'
    ax[i].imshow((load_img(path1 + img_path[i])/255) * (load_img(path +␣
 ↪mask_path[i])/255))
    ax[i].set_xticks([]); ax[i].set_yticks([])

fig.tight_layout()
plt.show()
```



[227]:
```
#data  preparation
X_train, X_test, y_train, y_test = train_test_split(img_path, mask_path,␣
 ↪test_size=0.2, random_state=22)
len(X_train), len(X_test)
```

[227]: (160, 40)

[228]:
```
#batch generation----------------------
def load_data(path_list, gray=False):
    data=[]
    for path in tqdm(path_list):
        img= load_img(path)
        if gray:
            img= img[:, :, 0:1]
        img= cv2.resize(img, (w, h))
        data.append(img)
    return np.array(data)
```

[229]:
```
#train data generation---------------------
X_train= load_data([BASE_DIR + 'Images/' + x for x in X_train])/255.0
X_test= load_data([BASE_DIR + 'Images/' + x for x in X_test])/255.0

X_train.shape, X_test.shape
```

```
  0%|          | 0/160 [00:00<?, ?it/s]
  0%|          | 0/40 [00:00<?, ?it/s]
```

[229]:
```
((160, 256, 256, 3), (40, 256, 256, 3))
```

[230]:
```
##test data generation---------------------
Y_train= load_data([BASE_DIR + 'Labels/' + x for x in y_train], gray=True)/255.0
Y_test= load_data([BASE_DIR + 'Labels/' + x for x in y_test], gray=True)/255.0
Y_train= Y_train.reshape(-1, w, h, 1)
Y_test= Y_test.reshape(-1, w, h, 1)

Y_train.shape, Y_test.shape
```

```
  0%|          | 0/160 [00:00<?, ?it/s]
  0%|          | 0/40 [00:00<?, ?it/s]
```

[230]:
```
((160, 256, 256, 1), (40, 256, 256, 1))
```

[231]:
```
# Convolutional blocks-----------------

def conv_block(inputs,n_filters,max_pool=True):

    x =␣
 ↪Conv2D(n_filters,3,padding='same',kernel_initializer='he_normal',use_bias=False)(inputs)
    x = BatchNormalization()(x)
    x = LeakyReLU(0.2)(x)
    x =␣
 ↪Conv2D(n_filters,3,padding='same',kernel_initializer='he_normal',use_bias=False)(x)
    x = BatchNormalization()(x)
    x = LeakyReLU(0.2)(x)
    skip = x

    if max_pool:
        next_layer = MaxPool2D()(x)
    else:
        next_layer = x
    return next_layer, skip

# upsampling block
def up_block(reg_inputs,skip_inputs,n_filters):
```

```
    x = Conv2DTranspose(n_filters,3,2,padding='same')(reg_inputs)
    x = concatenate([x,skip_inputs],axis=3)
    x = conv_block(x,n_filters,max_pool=False)[0]

    return x
```

[232]:
```
# Unet model---------------------

def unet(input_size=(h,w,ch),number_of_classes=1):
    inputs = Input(shape=input_size)
    cb1 = conv_block(inputs,32)
    cb2 = conv_block(cb1[0],64)
    cb3 = conv_block(cb2[0],128)
    cb4 = conv_block(cb3[0],256)
    cb5 = conv_block(cb4[0],512,max_pool=False)

    up1 = up_block(cb5[0],cb4[1],256)
    up2 = up_block(up1,cb3[1],128)
    up3 = up_block(up2,cb2[1],64)
    up4 = up_block(up3,cb1[1],32)

    conv1 =␣
 ↪Conv2D(32,3,padding='same',kernel_initializer='he_normal',use_bias=False)(up4)
    bn = BatchNormalization()(conv1)
    lrl = LeakyReLU(0.2)(bn)
    outputs =␣
 ↪Conv2D(number_of_classes,1,padding='same',activation='sigmoid')(lrl)

    unet = Model(inputs=inputs,outputs=outputs)
    return unet
```

[233]:
```
# IoU loss-------------

def jaccard_coef(y_true,y_pred,smooth=1):
    y_true_f = K.flatten(y_true)
    y_pred_f = K.flatten(y_pred)
    intersection = K.sum(y_true_f*y_pred_f)
    return (intersection+smooth)/(K.sum(y_true_f)+K.
 ↪sum(y_pred_f)-intersection+smooth)

# Jaccard loss-----------------
def jaccard_loss(y_true,y_pred,smooth=1):

    return -jaccard_coef(y_true,y_pred,smooth)
```

[234]:
```
# Defining our model----------------
model = unet()

# Plotting  model---------------------------
tf.keras.utils.plot_model(
    model,
    to_file="model.png",
    show_shapes=True,
    show_layer_names=True,
    dpi=60
)
#Summary of model------------------
model.summary()
```

```
Model: "model"
__________________________________________________________________________________
__________________
 Layer (type)                   Output Shape         Param #     Connected to
==================================================================================
==================
 input_1 (InputLayer)           [(None, 256, 256, 3  0           []
                                )]

 conv2d (Conv2D)                (None, 256, 256, 32  864
['input_1[0][0]']
                                )

 batch_normalization (BatchNorm  (None, 256, 256, 32  128
['conv2d[0][0]']
 alization)                     )

 leaky_re_lu (LeakyReLU)        (None, 256, 256, 32  0
['batch_normalization[0][0]']
                                )

 conv2d_1 (Conv2D)              (None, 256, 256, 32  9216
['leaky_re_lu[0][0]']
                                )

 batch_normalization_1 (BatchNo  (None, 256, 256, 32  128
['conv2d_1[0][0]']
 rmalization)                   )

 leaky_re_lu_1 (LeakyReLU)      (None, 256, 256, 32  0
['batch_normalization_1[0][0]']
                                )
```

```
 max_pooling2d (MaxPooling2D)   (None, 128, 128, 32  0
['leaky_re_lu_1[0][0]']
                                )

 conv2d_2 (Conv2D)              (None, 128, 128, 64  18432
['max_pooling2d[0][0]']
                                )

 batch_normalization_2 (BatchNo  (None, 128, 128, 64  256
['conv2d_2[0][0]']
 rmalization)                   )

 leaky_re_lu_2 (LeakyReLU)      (None, 128, 128, 64  0
['batch_normalization_2[0][0]']
                                )

 conv2d_3 (Conv2D)              (None, 128, 128, 64  36864
['leaky_re_lu_2[0][0]']
                                )

 batch_normalization_3 (BatchNo  (None, 128, 128, 64  256
['conv2d_3[0][0]']
 rmalization)                   )

 leaky_re_lu_3 (LeakyReLU)      (None, 128, 128, 64  0
['batch_normalization_3[0][0]']
                                )

 max_pooling2d_1 (MaxPooling2D)  (None, 64, 64, 64)  0
['leaky_re_lu_3[0][0]']

 conv2d_4 (Conv2D)              (None, 64, 64, 128)  73728
['max_pooling2d_1[0][0]']

 batch_normalization_4 (BatchNo  (None, 64, 64, 128)  512
['conv2d_4[0][0]']
 rmalization)

 leaky_re_lu_4 (LeakyReLU)      (None, 64, 64, 128)  0
['batch_normalization_4[0][0]']

 conv2d_5 (Conv2D)              (None, 64, 64, 128)  147456
['leaky_re_lu_4[0][0]']

 batch_normalization_5 (BatchNo  (None, 64, 64, 128)  512
['conv2d_5[0][0]']
 rmalization)
```

```
 leaky_re_lu_5 (LeakyReLU)      (None, 64, 64, 128)  0
['batch_normalization_5[0][0]']

 max_pooling2d_2 (MaxPooling2D)  (None, 32, 32, 128)  0
['leaky_re_lu_5[0][0]']

 conv2d_6 (Conv2D)              (None, 32, 32, 256)  294912
['max_pooling2d_2[0][0]']

 batch_normalization_6 (BatchNo  (None, 32, 32, 256)  1024
['conv2d_6[0][0]']
 rmalization)

 leaky_re_lu_6 (LeakyReLU)      (None, 32, 32, 256)  0
['batch_normalization_6[0][0]']

 conv2d_7 (Conv2D)              (None, 32, 32, 256)  589824
['leaky_re_lu_6[0][0]']

 batch_normalization_7 (BatchNo  (None, 32, 32, 256)  1024
['conv2d_7[0][0]']
 rmalization)

 leaky_re_lu_7 (LeakyReLU)      (None, 32, 32, 256)  0
['batch_normalization_7[0][0]']

 max_pooling2d_3 (MaxPooling2D)  (None, 16, 16, 256)  0
['leaky_re_lu_7[0][0]']

 conv2d_8 (Conv2D)              (None, 16, 16, 512)  1179648
['max_pooling2d_3[0][0]']

 batch_normalization_8 (BatchNo  (None, 16, 16, 512)  2048
['conv2d_8[0][0]']
 rmalization)

 leaky_re_lu_8 (LeakyReLU)      (None, 16, 16, 512)  0
['batch_normalization_8[0][0]']

 conv2d_9 (Conv2D)              (None, 16, 16, 512)  2359296
['leaky_re_lu_8[0][0]']

 batch_normalization_9 (BatchNo  (None, 16, 16, 512)  2048
['conv2d_9[0][0]']
 rmalization)

 leaky_re_lu_9 (LeakyReLU)      (None, 16, 16, 512)  0
['batch_normalization_9[0][0]']
```

```
 conv2d_transpose (Conv2DTransp  (None, 32, 32, 256)  1179904
['leaky_re_lu_9[0][0]']
 ose)

 concatenate (Concatenate)      (None, 32, 32, 512)  0
['conv2d_transpose[0][0]',
'leaky_re_lu_7[0][0]']

 conv2d_10 (Conv2D)             (None, 32, 32, 256)  1179648
['concatenate[0][0]']

 batch_normalization_10 (BatchN  (None, 32, 32, 256)  1024
['conv2d_10[0][0]']
 ormalization)

 leaky_re_lu_10 (LeakyReLU)     (None, 32, 32, 256)  0
['batch_normalization_10[0][0]']

 conv2d_11 (Conv2D)             (None, 32, 32, 256)  589824
['leaky_re_lu_10[0][0]']

 batch_normalization_11 (BatchN  (None, 32, 32, 256)  1024
['conv2d_11[0][0]']
 ormalization)

 leaky_re_lu_11 (LeakyReLU)     (None, 32, 32, 256)  0
['batch_normalization_11[0][0]']

 conv2d_transpose_1 (Conv2DTran  (None, 64, 64, 128)  295040
['leaky_re_lu_11[0][0]']
 spose)

 concatenate_1 (Concatenate)    (None, 64, 64, 256)  0
['conv2d_transpose_1[0][0]',
'leaky_re_lu_5[0][0]']

 conv2d_12 (Conv2D)             (None, 64, 64, 128)  294912
['concatenate_1[0][0]']

 batch_normalization_12 (BatchN  (None, 64, 64, 128)  512
['conv2d_12[0][0]']
 ormalization)

 leaky_re_lu_12 (LeakyReLU)     (None, 64, 64, 128)  0
['batch_normalization_12[0][0]']

 conv2d_13 (Conv2D)             (None, 64, 64, 128)  147456
```

```
['leaky_re_lu_12[0][0]']

 batch_normalization_13 (BatchN  (None, 64, 64, 128)  512
['conv2d_13[0][0]']
 ormalization)

 leaky_re_lu_13 (LeakyReLU)     (None, 64, 64, 128)  0
['batch_normalization_13[0][0]']

 conv2d_transpose_2 (Conv2DTran  (None, 128, 128, 64  73792
['leaky_re_lu_13[0][0]']
 spose)                         )

 concatenate_2 (Concatenate)    (None, 128, 128, 12  0
['conv2d_transpose_2[0][0]',
                                8)
'leaky_re_lu_3[0][0]']

 conv2d_14 (Conv2D)             (None, 128, 128, 64  73728
['concatenate_2[0][0]']
                                )

 batch_normalization_14 (BatchN  (None, 128, 128, 64  256
['conv2d_14[0][0]']
 ormalization)                  )

 leaky_re_lu_14 (LeakyReLU)     (None, 128, 128, 64  0
['batch_normalization_14[0][0]']
                                )

 conv2d_15 (Conv2D)             (None, 128, 128, 64  36864
['leaky_re_lu_14[0][0]']
                                )

 batch_normalization_15 (BatchN  (None, 128, 128, 64  256
['conv2d_15[0][0]']
 ormalization)                  )

 leaky_re_lu_15 (LeakyReLU)     (None, 128, 128, 64  0
['batch_normalization_15[0][0]']
                                )

 conv2d_transpose_3 (Conv2DTran  (None, 256, 256, 32  18464
['leaky_re_lu_15[0][0]']
 spose)                         )

 concatenate_3 (Concatenate)    (None, 256, 256, 64  0
['conv2d_transpose_3[0][0]',
```

```
                                )
'leaky_re_lu_1[0][0]']

 conv2d_16 (Conv2D)             (None, 256, 256, 32  18432
['concatenate_3[0][0]']
                                )

 batch_normalization_16 (BatchN  (None, 256, 256, 32  128
['conv2d_16[0][0]']
 ormalization)                  )

 leaky_re_lu_16 (LeakyReLU)     (None, 256, 256, 32  0
['batch_normalization_16[0][0]']
                                )

 conv2d_17 (Conv2D)             (None, 256, 256, 32  9216
['leaky_re_lu_16[0][0]']
                                )

 batch_normalization_17 (BatchN  (None, 256, 256, 32  128
['conv2d_17[0][0]']
 ormalization)                  )

 leaky_re_lu_17 (LeakyReLU)     (None, 256, 256, 32  0
['batch_normalization_17[0][0]']
                                )

 conv2d_18 (Conv2D)             (None, 256, 256, 32  9216
['leaky_re_lu_17[0][0]']
                                )

 batch_normalization_18 (BatchN  (None, 256, 256, 32  128
['conv2d_18[0][0]']
 ormalization)                  )

 leaky_re_lu_18 (LeakyReLU)     (None, 256, 256, 32  0
['batch_normalization_18[0][0]']
                                )

 conv2d_19 (Conv2D)             (None, 256, 256, 1)  33
['leaky_re_lu_18[0][0]']

==================================================================================
==================
Total params: 8,648,673
Trainable params: 8,642,721
Non-trainable params: 5,952
----------------------------------------------------------------------------------
```

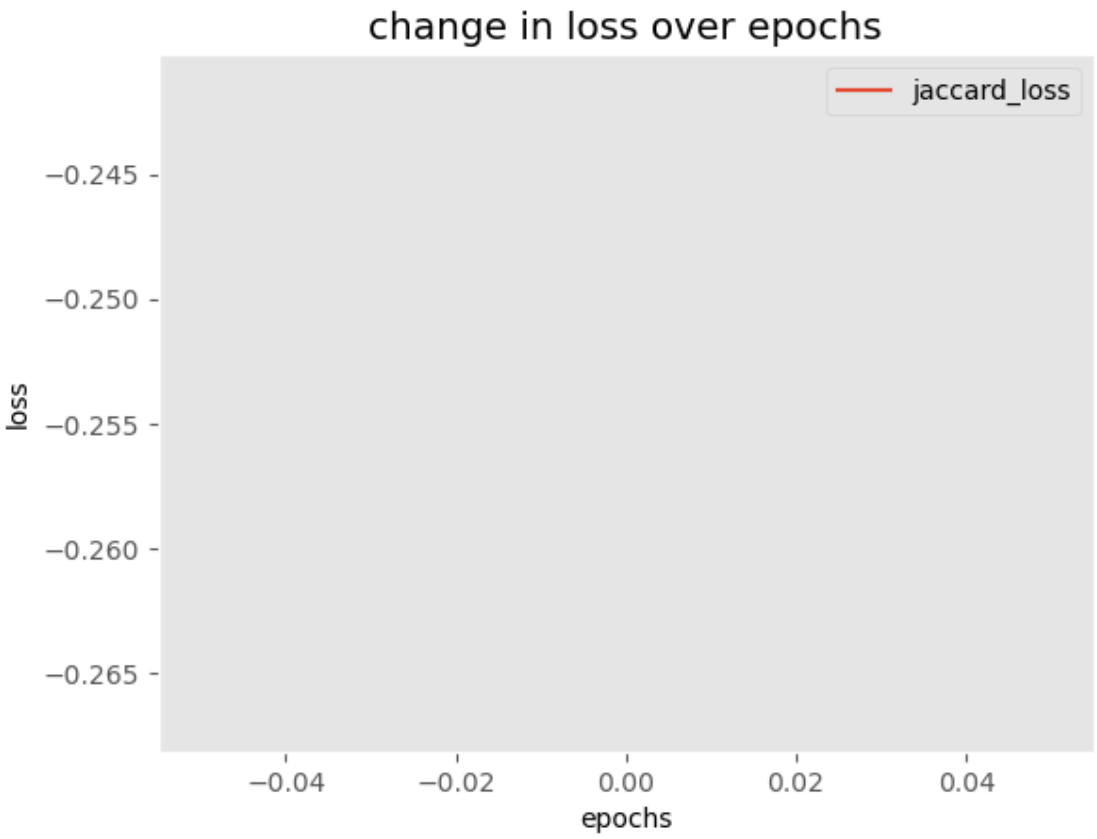
```
------------------
```

[235]:
```
#compile model--------------------
model.compile(optimizer=tf.keras.optimizers.
 ↪Adam(1e-3),loss=[jaccard_loss],metrics=[jaccard_coef])
```

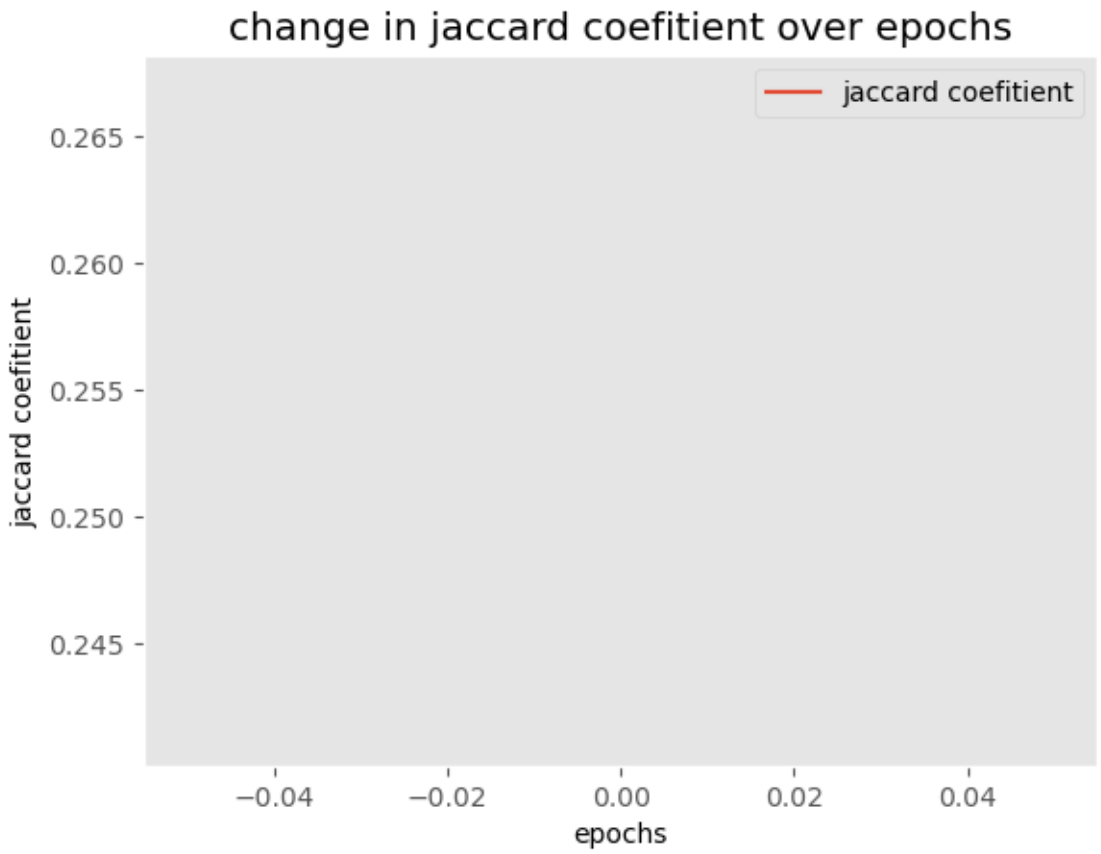
[185]:
```
#Train model---------------------------
nbatch_size=16
nepochs=20
history = model.
 ↪fit(X_train,Y_train,batch_size=nbatch_size,epochs=nepochs,validation_split=0.
 ↪2)
```

```
16/16 [==============================] - 169s 10s/step - loss: -0.2542 -
jaccard_coef: 0.2542 - val_loss: -0.0696 - val_jaccard_coef: 0.0696
```

[186]:
```
# Plotting loss change over epochs---------------
nrange=nepochs
x = [i for i in range(nrange)]
plt.plot(x,history.history['loss'])
plt.title('change in loss over epochs')
plt.legend(['jaccard_loss'])
plt.xlabel('epochs')
plt.ylabel('loss')
#plt.axis('off')
plt.grid(None)
plt.show()
plt.tight_layout()
```



[187]:
```
# Plotting IoU change over epochs----------------------
x = [i for i in range(nrange)]
plt.plot(x,history.history['jaccard_coef'])
plt.title('change in jaccard coefitient over epochs')
plt.legend(['jaccard coefitient'])
plt.xlabel('epochs')
plt.ylabel('jaccard coefitient')
plt.grid(None)
plt.show()
plt.tight_layout()
```



[188]:
```
# Creating predictions on our test set-----------------
predictions = model.predict(X_test)
```

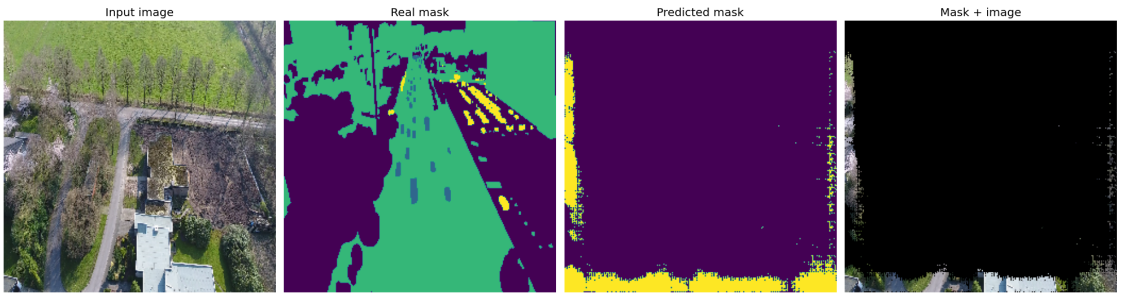
```
2/2 [==============================] - 7s 2s/step
```

[189]:
```
# create predictes mask--------------

def create_mask(predictions,input_shape=(w,h,1)):
    mask = np.zeros(input_shape)
    mask[predictions>0.5] = 1
    return mask
```

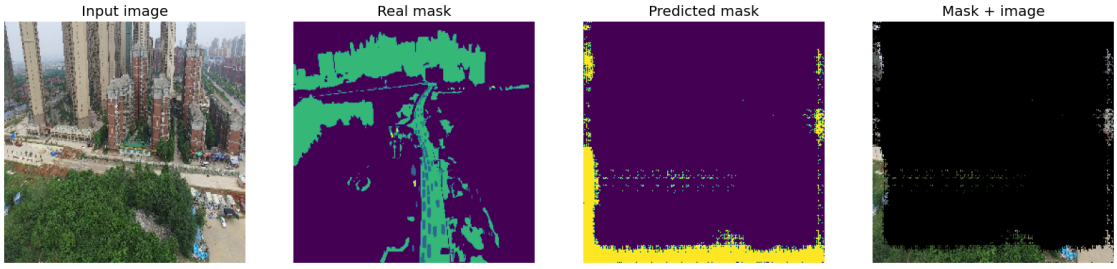
[218]:
```
# Ploting results for one image

def plot_results_for_one_sample(sample_index):

    mask = create_mask(predictions[sample_index])

    fig = plt.figure(figsize=(20,20))
    fig.add_subplot(1,4,1)
```

```
    plt.title('Input image')
    plt.imshow(X_test[sample_index])
    plt.axis('off')
    plt.grid(None)

    fig.add_subplot(1,4,2)
    plt.title('Real mask')
    plt.imshow(Y_test[sample_index])
    plt.axis('off')
    plt.grid(None)

    fig.add_subplot(1,4,3)
    plt.title('Predicted mask')
    plt.imshow(mask)
    plt.axis('off')
    plt.grid(None)

    fig.add_subplot(1,4,4)
    plt.title("Mask + image")
    plt.imshow(X_test[sample_index]*mask)
    plt.grid(None)
    plt.axis('off')
    fig.tight_layout()
```

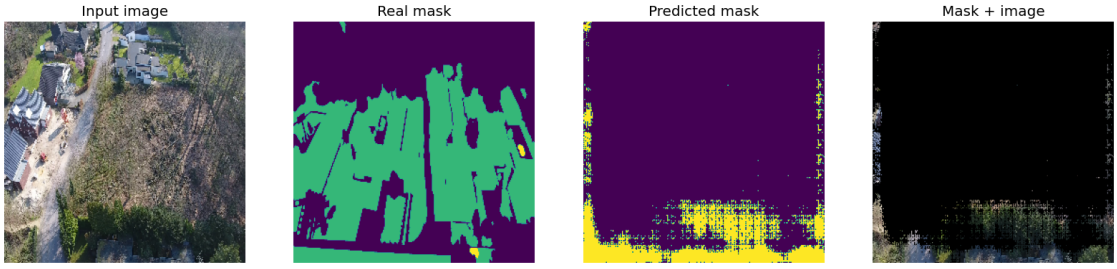
[219]:
```
#Show predicted result---------------
plot_results_for_one_sample(0)
```



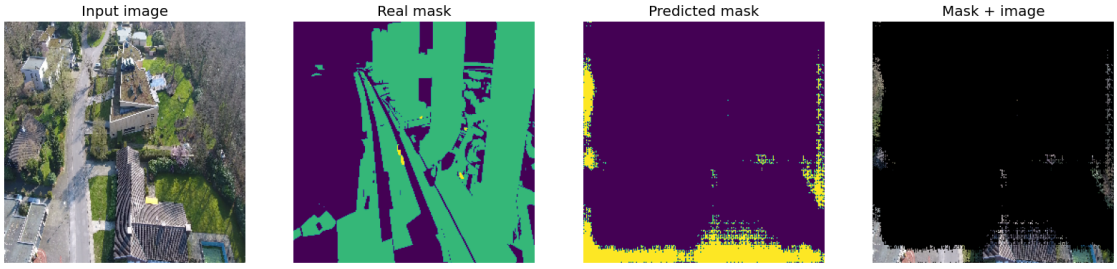
[212]:
```
#Show predicted result---------------
plot_results_for_one_sample(1)
```



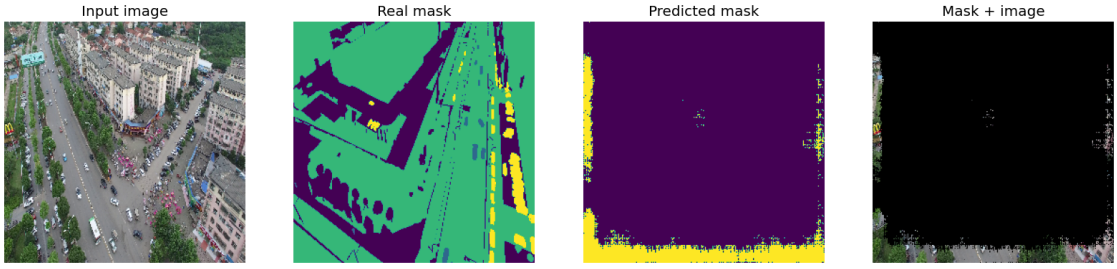
[213]:
```
#Show predicted result---------------
plot_results_for_one_sample(2)
```



[214]:
```
#Show predicted result---------------
plot_results_for_one_sample(4)
```



[215]:
```
#Show predicted result---------------
plot_results_for_one_sample(5)
```


Input image
Real mask
Predicted mask
Mask + image

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