Road Finder

Initial Config

```
from google.colab import drive
drive.mount('/content/gdrive')
base_path = 'gdrive/My\ Drive/road_finder_data/'
%cd gdrive/My\ Drive/road_finder_data/
```

```
     Drive already mounted at /content/gdrive; to attempt to forcibly remount, call drive
     [Errno 2] No such file or directory: 'gdrive/My Drive/road_finder_data/'
     /content/gdrive/My Drive/road_finder_data
```

```
import cv2
import h5py
import random
import numpy as np
import tensorflow as tf
import keras
import time
from matplotlib import pyplot as plt
from keras import backend as K
from keras.models import Model, load_model
from keras.metrics import MeanIoU
from keras.layers import Input
from keras.layers.core import Lambda
from keras.layers.convolutional import Conv2D, Conv2DTranspose
from keras.layers.pooling import MaxPooling2D
from keras.layers.merge import concatenate
from keras import optimizers
from keras.callbacks import EarlyStopping, ModelCheckpoint, ReduceLROnPlateau
```

Pathes to datasets

```
train_file = './big/train.hdf5'
```

Constants

```
ACT_FUNCTION = 'relu'
KERNEL_INIT = 'he_normal'
PADDING_TYPE = 'same'
EPOCHS = 100
LEARNING_RATE = 0.0001
BATCH_SIZE = 16
CHECKPOINT_MODEL_PATH = "./Models/road_mapper_2.h5"
```

```
FINAL_MODEL_PATH = "./Models/road_mapper_final_relu_500"
```

Loss function

```
def soft_dice_loss(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 1 - (2. * intersection + smooth) / (K.sum(y_true_f) + K.sum(y_pred_f) + smooth)
```

Intersection over Union

```
def iou_coef(y_true, y_pred, smooth = 1):
  I = K.sum(K.abs(y_true * y_pred), axis=[1,2,3])
  U = K.sum(y_true,[1,2,3]) + K.sum(y_pred, [1,2,3]) - I
  iou = K.mean((I + smooth) / (U + smooth), axis=0)
  return iou
```

Load Train images

```
hfile = h5py.File(train_file, 'r')

train_images = np.array(hfile.get('images'))[:500]
print(train_images.shape)

train_masks = np.array(hfile.get('masks'))[:500]
print(train_masks.shape)

hfile.close()
```

```
    (500, 256, 256, 3)
    (500, 256, 256)
```

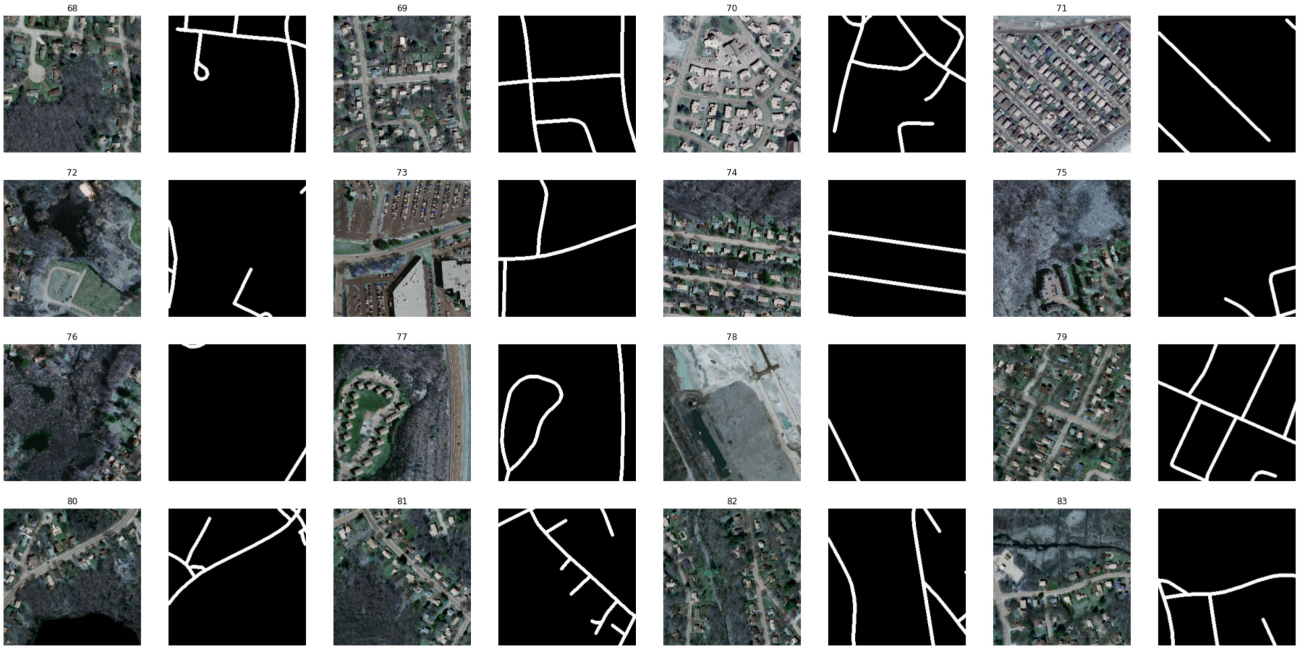
View samples

```
random.seed(1)
plt.figure(figsize=(32,16))
x, y = 4, 4
ipos = random.randint(0, len(train_images)-x*y)
for i in range(y):
  for j in range(x):

    pos = ipos + i*x + j

    plt.subplot(y, x*2, i*x*2+j*2+1)
    plt.imshow(train_images[pos])
    plt.title(pos)
    plt.axis('off')

    plt.subplot(y, x*2, i*x*2+(j*2)+2)
    plt.imshow(train_masks[pos], cmap='gray', vmin=0, vmax=255)
    plt.axis('off')
plt.show()
```



Create Model

```
inputs = Input((256, 256, 3))
s = Lambda(lambda x: x / 255) (inputs)

conv1 = Conv2D(16, 3, activation=ACT_FUNCTION, kernel_initializer=KERNEL_INIT, padding=PAD
conv1 = Conv2D(16, 3, activation=ACT_FUNCTION, kernel_initializer=KERNEL_INIT, padding=PAD
pooling1 = MaxPooling2D() (conv1)

conv2 = Conv2D(32, 3, activation=ACT_FUNCTION, kernel_initializer=KERNEL_INIT, padding=PAD
conv2 = Conv2D(32, 3, activation=ACT_FUNCTION, kernel_initializer=KERNEL_INIT, padding=PAD
pooling2 = MaxPooling2D() (conv2)

conv3 = Conv2D(64, 3, activation=ACT_FUNCTION, kernel_initializer=KERNEL_INIT, padding=PAD
conv3 = Conv2D(64, 3, activation=ACT_FUNCTION, kernel_initializer=KERNEL_INIT, padding=PAD
pooling3 = MaxPooling2D() (conv3)

conv4 = Conv2D(128, 3, activation=ACT_FUNCTION, kernel_initializer=KERNEL_INIT, padding=PA
conv4 = Conv2D(128, 3, activation=ACT_FUNCTION, kernel_initializer=KERNEL_INIT, padding=PA
pooling4 = MaxPooling2D() (conv4)
```

```
conv5 = Conv2D(256, 3, activation=ACT_FUNCTION, kernel_initializer=KERNEL_INIT, padding=PA
conv5 = Conv2D(256, 3, activation=ACT_FUNCTION, kernel_initializer=KERNEL_INIT, padding=PA

upsample6 = Conv2DTranspose(128, 2, strides=(2,2), padding=PADDING_TYPE) (conv5)
upsample6 = concatenate([upsample6, conv4])
conv6 = Conv2D(128, 3, activation=ACT_FUNCTION, kernel_initializer=KERNEL_INIT, padding=PA
conv6 = Conv2D(128, 3, activation=ACT_FUNCTION, kernel_initializer=KERNEL_INIT, padding=PA

upsample7 = Conv2DTranspose(64, 2, strides=(2, 2), padding=PADDING_TYPE) (conv6)
upsample7 = concatenate([upsample7, conv3])
conv7 = Conv2D(64, 3, activation=ACT_FUNCTION, kernel_initializer=KERNEL_INIT, padding=PAD
conv7 = Conv2D(64, 3, activation=ACT_FUNCTION, kernel_initializer=KERNEL_INIT, padding=PAD

upsample8 = Conv2DTranspose(32, 2, strides=(2, 2), padding=PADDING_TYPE) (conv7)
upsample8 = concatenate([upsample8, conv2])
conv8 = Conv2D(32, 3, activation=ACT_FUNCTION, kernel_initializer=KERNEL_INIT, padding=PAD
conv8 = Conv2D(32, 3, activation=ACT_FUNCTION, kernel_initializer=KERNEL_INIT, padding=PAD

upsample9 = Conv2DTranspose(16, 2, strides=(2, 2), padding=PADDING_TYPE) (conv8)
upsample9 = concatenate([upsample9, conv1], axis=3)
conv9 = Conv2D(16, 3, activation=ACT_FUNCTION, kernel_initializer=KERNEL_INIT, padding=PAD
conv9 = Conv2D(16, 3, activation=ACT_FUNCTION, kernel_initializer=KERNEL_INIT, padding=PAD

outputs = Conv2D(1, 1, activation='sigmoid') (conv9)

model = Model(inputs=[inputs], outputs=[outputs])
model.summary()
```

```
conv2d_23 (Conv2D)              (None, 64, 64, 64)   18496       max_pooling2d_5[0

conv2d_24 (Conv2D)              (None, 64, 64, 64)   36928       conv2d_23[0][0]

max_pooling2d_6 (MaxPooling2D)  (None, 32, 32, 64)   0           conv2d_24[0][0]

conv2d_25 (Conv2D)              (None, 32, 32, 128)  73856       max_pooling2d_6[0

conv2d_26 (Conv2D)              (None, 32, 32, 128)  147584      conv2d_25[0][0]

max_pooling2d_7 (MaxPooling2D)  (None, 16, 16, 128)  0           conv2d_26[0][0]

conv2d_27 (Conv2D)              (None, 16, 16, 256)  295168      max_pooling2d_7[0

conv2d_28 (Conv2D)              (None, 16, 16, 256)  590080      conv2d_27[0][0]

conv2d_transpose_4 (Conv2DTrans (None, 32, 32, 128)  131200      conv2d_28[0][0]

concatenate_4 (Concatenate)     (None, 32, 32, 256)  0           conv2d_transpose_
                                                                 conv2d_26[0][0]

conv2d_29 (Conv2D)              (None, 32, 32, 128)  295040      concatenate_4[0][

conv2d_30 (Conv2D)              (None, 32, 32, 128)  147584      conv2d_29[0][0]

conv2d_transpose_5 (Conv2DTrans (None, 64, 64, 64)   32832       conv2d_30[0][0]

concatenate_5 (Concatenate)     (None, 64, 64, 128)  0           conv2d_transpose_
                                                                 conv2d_24[0][0]
```

```
conv2d_31 (Conv2D)             (None, 64, 64, 64)   73792       concatenate_5[0][
________________________________________________________________________________
conv2d_32 (Conv2D)             (None, 64, 64, 64)   36928       conv2d_31[0][0]
________________________________________________________________________________
conv2d_transpose_6 (Conv2DTrans (None, 128, 128, 32) 8224       conv2d_32[0][0]
________________________________________________________________________________
concatenate_6 (Concatenate)    (None, 128, 128, 64) 0           conv2d_transpose_
                                                                conv2d_22[0][0]
________________________________________________________________________________
conv2d_33 (Conv2D)             (None, 128, 128, 32) 18464       concatenate_6[0][
________________________________________________________________________________
conv2d_34 (Conv2D)             (None, 128, 128, 32) 9248        conv2d_33[0][0]
________________________________________________________________________________
conv2d_transpose_7 (Conv2DTrans (None, 256, 256, 16) 2064       conv2d_34[0][0]
________________________________________________________________________________
concatenate_7 (Concatenate)    (None, 256, 256, 32) 0           conv2d_transpose_
                                                                conv2d_20[0][0]
________________________________________________________________________________
conv2d_35 (Conv2D)             (None, 256, 256, 16) 4624        concatenate_7[0][
________________________________________________________________________________
conv2d_36 (Conv2D)             (None, 256, 256, 16) 2320        conv2d_35[0][0]
________________________________________________________________________________
conv2d_37 (Conv2D)             (None, 256, 256, 1)  17          conv2d_36[0][0]
================================================================================
Total params: 1,941,105
Trainable params: 1,941,105
Non-trainable params: 0
```

Compile model

```
train_masks = np.expand_dims(train_masks, -1)
train_masks.shape
```

```
(500, 256, 256, 1)
```

```
opt = keras.optimizers.Adam(LEARNING_RATE)
model.compile(
      optimizer=opt,
      loss=soft_dice_loss,
      metrics=[iou_coef]) #MeanIoU(num_classes=2)
```

```
tf.test.gpu_device_name()
```

```
'/device:GPU:0'
```

```
start_time = time.time()
```

```
history = model.fit(train_images,
                    train_masks/255,
                    validation_split = 0.1,
                    epochs=EPOCHS,
batch_size = BATCH_SIZE,
callbacks = [
             ModelCheckpoint(CHECKPOINT_MODEL_PATH,
                             monitor="val_loss",
                             mode="min",
                             save_best_only = True,
                             verbose=1),
             EarlyStopping(monitor = 'val_loss',
                           min_delta = 0,
                           patience = 5,
                           verbose = 1,
                           restore_best_weights = True),
             ReduceLROnPlateau(monitor='val_loss',
                               factor=0.1,
                               patience=4,
                               verbose=1,
                               min_delta=1e-4)
             ]
   )
```

```
29/29 [==============================] - 4s 124ms/step - loss: 0.3641 - iou_coef: 

Epoch 00032: val_loss improved from 0.42877 to 0.42841, saving model to ./Models/r
Epoch 33/100
29/29 [==============================] - 4s 124ms/step - loss: 0.3532 - iou_coef: 

Epoch 00033: val_loss improved from 0.42841 to 0.42736, saving model to ./Models/r
Epoch 34/100
29/29 [==============================] - 4s 124ms/step - loss: 0.3425 - iou_coef: 

Epoch 00034: val_loss improved from 0.42736 to 0.42154, saving model to ./Models/r
Epoch 35/100
29/29 [==============================] - 4s 124ms/step - loss: 0.3348 - iou_coef: 

Epoch 00035: val_loss did not improve from 0.42154
Epoch 36/100
29/29 [==============================] - 4s 124ms/step - loss: 0.3337 - iou_coef: 

Epoch 00036: val_loss did not improve from 0.42154
Epoch 37/100
29/29 [==============================] - 4s 125ms/step - loss: 0.3308 - iou_coef: 

Epoch 00037: val_loss improved from 0.42154 to 0.41458, saving model to ./Models/r
Epoch 38/100
29/29 [==============================] - 4s 125ms/step - loss: 0.3106 - iou_coef: 

Epoch 00038: val_loss did not improve from 0.41458
Epoch 39/100
29/29 [==============================] - 4s 126ms/step - loss: 0.3287 - iou_coef: 

Epoch 00039: val_loss did not improve from 0.41458
Epoch 40/100
29/29 [==============================] - 4s 126ms/step - loss: 0.3121 - iou_coef: 

Epoch 00040: val_loss improved from 0.41458 to 0.40717, saving model to ./Models/r
Epoch 41/100

29/29 [==============================] - 4s 125ms/step - loss: 0.2909 - iou_coef: 

Epoch 00041: val_loss did not improve from 0.40717
Epoch 42/100
29/29 [==============================] - 4s 126ms/step - loss: 0.2966 - iou_coef:

Epoch 00042: val_loss did not improve from 0.40717
Epoch 43/100
29/29 [==============================] - 4s 126ms/step - loss: 0.3012 - iou_coef:

Epoch 00043: val_loss did not improve from 0.40717
Epoch 44/100
29/29 [==============================] - 4s 125ms/step - loss: 0.2777 - iou_coef:

Epoch 00044: val_loss did not improve from 0.40717

Epoch 00044: ReduceLROnPlateau reducing learning rate to 9.999999747378752e-06.
Epoch 45/100
29/29 [==============================] - 4s 125ms/step - loss: 0.2629 - iou_coef:

Epoch 00045: val_loss did not improve from 0.40717
Restoring model weights from the end of the best epoch.
```

```
end_time = time.time()
total_time = end_time - start_time
print("Total training time: {}s".format(total_time))
```

```
Total training time: 172.62069392204285s
```

```
model.save(FINAL_MODEL_PATH)
```

```
INFO:tensorflow:Assets written to: ./Models/road_mapper_final_relu_500/assets
```

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