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
/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
TRAIN_SIZE = 200
CHECKPOINT_MODEL_PATH = "./Models/road_mapper_2.h5"
```

```
FINAL_MODEL_PATH = "./Models/road_mapper_final_relu_"+str(TRAIN_SIZE)
```

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'))[:TRAIN_SIZE]
print(train_images.shape)

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

hfile.close()
```

```
(200, 256, 256, 3)
(200, 256, 256)
```

View samples

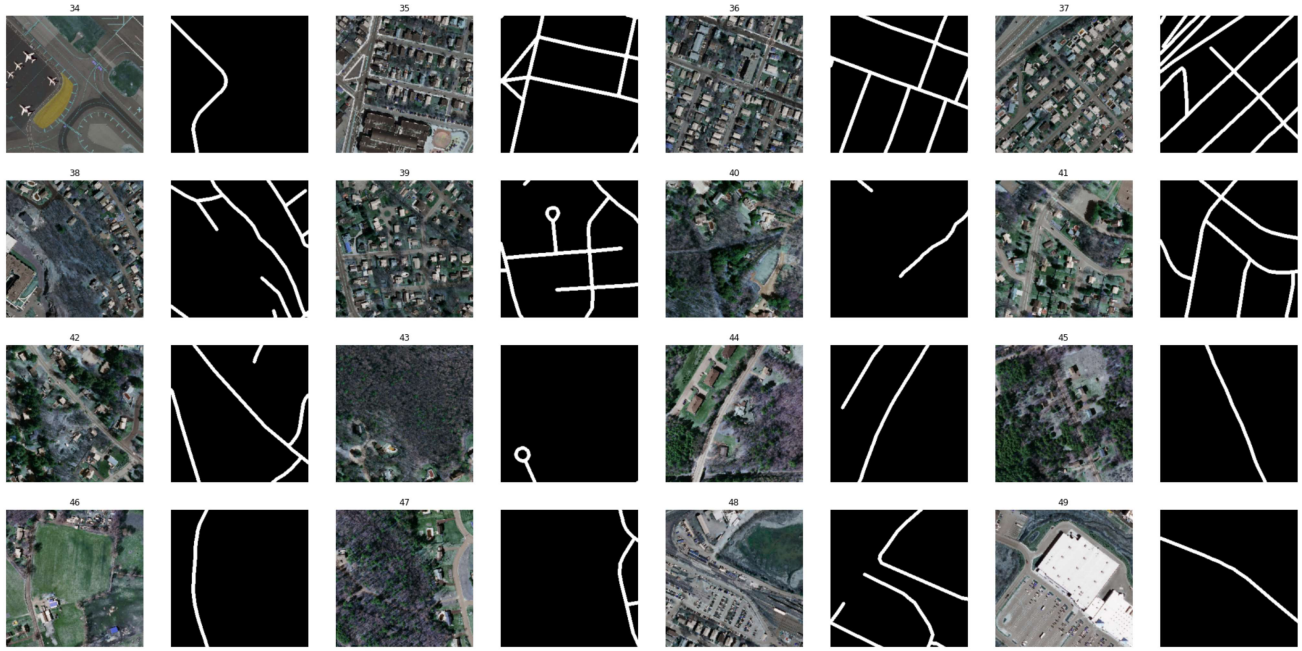
```
random.seed(1)
plt.figure(figsize=(32,16))
x, y = 4, 4
ipos = random.randint(0, len(train_images)-x*y)
for i in range(y):
  for j in range(x):

    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_2 (Conv2D)               (None, 128, 128, 32) 4640        max_pooling2d[0][(
conv2d_3 (Conv2D)               (None, 128, 128, 32) 9248        conv2d_2[0][0]
max_pooling2d_1 (MaxPooling2D)  (None, 64, 64, 32)   0           conv2d_3[0][0]
conv2d_4 (Conv2D)               (None, 64, 64, 64)   18496       max_pooling2d_1[0
conv2d_5 (Conv2D)               (None, 64, 64, 64)   36928       conv2d_4[0][0]
max_pooling2d_2 (MaxPooling2D)  (None, 32, 32, 64)   0           conv2d_5[0][0]
conv2d_6 (Conv2D)               (None, 32, 32, 128)  73856       max_pooling2d_2[0
conv2d_7 (Conv2D)               (None, 32, 32, 128)  147584      conv2d_6[0][0]
```

max_pooling2d_3 (MaxPooling2D)	(None, 16, 16, 128)	0	conv2d_7[0][0]
conv2d_8 (Conv2D)	(None, 16, 16, 256)	295168	max_pooling2d_3[0
conv2d_9 (Conv2D)	(None, 16, 16, 256)	590080	conv2d_8[0][0]
conv2d_transpose (Conv2DTranspo	(None, 32, 32, 128)	131200	conv2d_9[0][0]
concatenate (Concatenate)	(None, 32, 32, 256)	0	conv2d_transpose[0 conv2d_7[0][0]
conv2d_10 (Conv2D)	(None, 32, 32, 128)	295040	concatenate[0][0]
conv2d_11 (Conv2D)	(None, 32, 32, 128)	147584	conv2d_10[0][0]
conv2d_transpose_1 (Conv2DTrans	(None, 64, 64, 64)	32832	conv2d_11[0][0]
concatenate_1 (Concatenate)	(None, 64, 64, 128)	0	conv2d_transpose_ conv2d_5[0][0]
conv2d_12 (Conv2D)	(None, 64, 64, 64)	73792	concatenate_1[0][0
conv2d_13 (Conv2D)	(None, 64, 64, 64)	36928	conv2d_12[0][0]
conv2d_transpose_2 (Conv2DTrans	(None, 128, 128, 32)	8224	conv2d_13[0][0]
concatenate_2 (Concatenate)	(None, 128, 128, 64)	0	conv2d_transpose_ conv2d_3[0][0]
conv2d_14 (Conv2D)	(None, 128, 128, 32)	18464	concatenate_2[0][0
conv2d_15 (Conv2D)	(None, 128, 128, 32)	9248	conv2d_14[0][0]
conv2d_transpose_3 (Conv2DTrans	(None, 256, 256, 16)	2064	conv2d_15[0][0]
concatenate_3 (Concatenate)	(None, 256, 256, 32)	0	conv2d_transpose_ conv2d_1[0][0]
conv2d_16 (Conv2D)	(None, 256, 256, 16)	4624	concatenate_3[0][0
conv2d_17 (Conv2D)	(None, 256, 256, 16)	2320	conv2d_16[0][0]

Compile model

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

```
(200, 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)
                                ]
                       )
```

```
Epoch 1/100
12/12 [==============================] - 10s 297ms/step - loss: 0.8821 - iou_coef:

Epoch 00001: val_loss improved from inf to 0.85078, saving model to ./Models/road_
Epoch 2/100
12/12 [==============================] - 1s 125ms/step - loss: 0.8843 - iou_coef: 

Epoch 00002: val_loss improved from 0.85078 to 0.84496, saving model to ./Models/r
Epoch 3/100
12/12 [==============================] - 1s 124ms/step - loss: 0.8780 - iou_coef: 

Epoch 00003: val_loss improved from 0.84496 to 0.84219, saving model to ./Models/r
Epoch 4/100
12/12 [==============================] - 1s 125ms/step - loss: 0.8683 - iou_coef: 

Epoch 00004: val_loss improved from 0.84219 to 0.82429, saving model to ./Models/r
Epoch 5/100
12/12 [==============================] - 2s 126ms/step - loss: 0.8654 - iou_coef: 

Epoch 00005: val_loss did not improve from 0.82429
Epoch 6/100
12/12 [==============================] - 2s 127ms/step - loss: 0.8541 - iou_coef: 

Epoch 00006: val_loss improved from 0.82429 to 0.79178, saving model to ./Models/r
Epoch 7/100
12/12 [==============================] - 2s 127ms/step - loss: 0.8359 - iou_coef: 
```

```
Epoch 00007: val_loss improved from 0.79178 to 0.75259, saving model to ./Models/r
Epoch 8/100
12/12 [==============================] - 2s 126ms/step - loss: 0.7622 - iou_coef: 

Epoch 00008: val_loss improved from 0.75259 to 0.71488, saving model to ./Models/r
Epoch 9/100
12/12 [==============================] - 2s 128ms/step - loss: 0.7526 - iou_coef: 

Epoch 00009: val_loss did not improve from 0.71488
Epoch 10/100
12/12 [==============================] - 2s 128ms/step - loss: 0.7048 - iou_coef: 

Epoch 00010: val_loss improved from 0.71488 to 0.65818, saving model to ./Models/r
Epoch 11/100
12/12 [==============================] - 2s 127ms/step - loss: 0.7050 - iou_coef: 

Epoch 00011: val_loss did not improve from 0.65818
Epoch 12/100
12/12 [==============================] - 2s 129ms/step - loss: 0.7040 - iou_coef: 

Epoch 00012: val_loss improved from 0.65818 to 0.62417, saving model to ./Models/r
Epoch 13/100
12/12 [==============================] - 2s 129ms/step - loss: 0.7160 - iou_coef: 

Epoch 00013: val_loss did not improve from 0.62417
Epoch 14/100
12/12 [==============================] - 2s 129ms/step - loss: 0.6991 - iou_coef: 

Epoch 00014: val_loss did not improve from 0.62417
Epoch 15/100
12/12 [==============================] - 2s 129ms/step - loss: 0.6830 - iou_coef: 
```

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

```
Total training time: 50.18128728866577s
```

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

```
INFO:tensorflow:Assets written to: ./Models/road_mapper_final_relu_200/assets
```

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