Semantic segmentation on IDD Lite Dataset

IDD Lite dataset (<50MB) for semantic segmentaiton into 7 classes

Imports

```
import matplotlib.pyplot as plt
import tensorflow as tf
import cv2, os, random
import seaborn as sns
import pandas as pd
import numpy as np
import shutil
import datetime
from tensorflow import keras
from tensorflow.keras.layers import SeparableConv2D, ELU, Conv2DTranspose, Conv2D, Acti
from tensorflow.keras.callbacks import ModelCheckpoint, LearningRateScheduler, ReduceLR
from tensorflow.keras.initializers import lecun_normal
from tensorflow.keras.models import Model, Sequential
from tensorflow.keras.callbacks import TensorBoard
from tensorflow.keras import backend as K
from tensorflow.keras.optimizers import RMSprop
from keras import applications
```

```
Using TensorFlow backend.
```

```
print(tf.__version__)
print(tf.keras.__version__)
```

```
2.1.0
2.2.4-tf
```

Data cleaning

```
def VisSegmentation(image):
    if(isinstance(image, str)):
        image = cv2.imread(image, 0)
    for i in range(len(image)):
        for j in range(len(image[0])):
            if(image[i][j]!=0 or image[i][j]!=255):
                image[i][j] *=42.5
    plt.imshow(image)
```

```
print(os. listdir('idd20k_lite/gtFine'))
print(os. listdir('idd20k_lite/leftImg8bit'))
print(os. listdir('idd20k_lite/gtFine/train'))
```

```
for i in os.listdir(img_train):
    subpath = img_train + i + '/'
    for j in os.listdir(subpath):
        source = subpath + j
        dest = img_train + j
        shutil.copy(source, dest)

for i in os.listdir(seg_train):
    subpath = seg_train + i + '/'
    for j in os.listdir(subpath):
        source = subpath + j
        dest = seg_train + j
        shutil.copy(source, dest)

for i in os.listdir(img_val):
    subpath = img_val + i + '/'
    for j in os.listdir(subpath):
        source = subpath + j
        dest = img_val + j
        shutil.copy(source, dest)

for i in os.listdir(img_test):
    subpath = img_test + i + '/'
    for j in os.listdir(subpath):
        source = subpath + j
        dest = img_test + j
        shutil.copy(source, dest)

for i in os.listdir(seg_val):
    subpath = seg_val + i + '/'
    for j in os.listdir(subpath):
        source = subpath + j
        dest = seg_val + j
        shutil.copy(source, dest)
```

Train and test datasets

```
train_img = sorted([x for x in os.listdir(img_train) if "." in x])
train_seg = sorted([x for x in os.listdir(seg_train) if "." in x])
val_img = sorted([x for x in os.listdir(img_val) if "." in x])
val_seg = sorted([x for x in os.listdir(seg_val) if "." in x])
```

```
# separating semantic and instance segmentation labels
train_semantic = []
train_instance =[]
for i in range(len(train_seg)):
    if("inst" not in train_seg[i]):
        train_semantic.append(train_seg[i])
    else:
        train_instance.append(train_seg[i])

val_semantic = []
val_semantic = []
val_instance = []
for i in range(len(val_seg)):
    if("inst" not in val_seg[i]):
        val_semantic.append(val_seg[i])
    else:
        val_instance.append(val_seg[i])
```

```
def getImage(image):

    image = cv2.imread(image, 1)
    image = np.float32(cv2.resize(image, (256, 128))) / 255
    return image

def getSegmentation(image):
    seg_labels = np.zeros((128, 256, 8))
    image = cv2.imread(image, 1)
    image = cv2.resize(image, (256, 128))
    image = image[:, : , 0]
    image[image == 255] = 7
    for i in range(8):
        seg_labels[:, :, i] = (image == i ).astype(int)
    return seg_labels

def image_generator(image_paths, batch_size=32):

    #index = 0;
    while True:
          #np.random.seed(0)
          # Select image_paths (paths/indices) for the batch
          # batch_paths  = np.random.choice(a = image_paths,
          #                                 size = batch_size, replace=False)

          num_samples = len(image_paths)
          for offset in range(0, num_samples, batch_size):

            batch_paths = image_paths[offset:offset+batch_size]


            batch_input  = []
            batch_output = []

            # Read in each input, perform preprocessing and get labels
            for input_path in batch_paths:
                image = getImage(input_path)
                seg_path = input_path.replace('leftImg8bit', 'gtFine').replace(\
                  '_image.jpg', '_label.png')
                seg_mask = getSegmentation(seg_path)

                batch_input.append(image)
                batch_output.append(seg_mask)
            # Return a tuple of (input, output) to feed the network
            batch_x = np.array( batch_input )
            batch_y = np.array( batch_output )
            yield(batch_x, batch_y)
```

```
train_gen = image_generator(train_img, batch_size = 32)
val_gen = image_generator(val_img, batch_size=32)
```

```
X_train, Y_train, X_test, Y_test = [], [], [], []

for image, segmentation in zip(train_img, train_semantic):
    X_train.append(getImage(img_train + image))
    Y_train.append(getSegmentation(seg_train + segmentation))

for image, segmentation in zip(test_img, test_semantic):
    X_test.append(getImage(img_val + image))
    Y_test.append(getSegmentation(seg_val + segmentation))
```

```
X_train, Y_train, X_test, Y_test = np.array(X_train), np.array(Y_train), np.array(X_tes
```

```
print(X_train.shape, Y_train.shape)
print(X_test.shape, Y_test.shape)
```

Model

```
def residual_block(inp, f_in, f_out, strides = (1,1)):
    x = inp
    k = (3,3)

    x = SeparableConv2D(f_in, kernel_size=k, strides=(1,1), padding = "same")(x)
    x = BatchNormalization()(x)
    x = ELU()(x)

    x = SeparableConv2D(f_in, kernel_size=k, strides=strides, padding = "same")(x)
    x = BatchNormalization()(x)
    x = ELU()(x)

    x = SeparableConv2D(f_out, kernel_size=k, strides=(1,1), padding = "same")(x)
    x = BatchNormalization()(x)
    x = ELU()(x)

    inp = SeparableConv2D(f_out, kernel_size=k, strides=strides, padding = "same")(inp)
    inp = BatchNormalization()(inp)

    x = Add()([inp, x])
    x = ReLU()(x)

    return x
```

```
def build_model(inp):
    k=(3,3)

    x = Conv2D(16, kernel_size=k, strides = (1,1), padding = "same")(inp)
    x = BatchNormalization()(x)
    x = ReLU()(x)
    x = MaxPooling2D()(x)
    x = residual_block(x, 16, 32)
    x = MaxPooling2D()(x)
    x = residual_block(x, 32, 64)
    x = MaxPooling2D()(x)
    pool3 = x
    x = residual_block(x, 64, 96)
    x = MaxPooling2D()(x)
    pool4 = x
    x = residual_block(x, 96, 128)
    x = MaxPooling2D()(x)
    pool5 = x
    n = 2048
    nClasses = 8

    o = ( Conv2D( n , ( 7 , 7 ) , activation='relu' , padding='same', name="conv6", dat
    conv7 = ( Conv2D( n , ( 1, 1 ) , activation='relu' , padding='same', name="conv7",

    conv7_4 = Conv2DTranspose( nClasses , kernel_size=(4,4) , strides=(4,4) , use_bias=

    pool411 = ( Conv2D( nClasses , ( 1 , 1 ) , activation='relu' , padding='same', name
    pool411_2 = (Conv2DTranspose( nClasses , kernel_size=(2,2) , strides=(2,2) , use_bi

    pool311 = ( Conv2D( nClasses , ( 1 , 1) , activation='relu' , padding='same', name=

    o = Add(name="add")([pool411_2, pool311, conv7_4 ])
    o = Conv2DTranspose( nClasses , kernel_size=(8,8) , strides=(8,8) , use_bias=False,
    o = (Activation('softmax'))(o)

    return o

inp = Input((128,256,3))
model_f = build_model(inp)
model = Model(inputs= inp, outputs= model_f)
model.compile(optimizer = RMSprop(), loss = "categorical_crossentropy", metrics=["accur
model.summary()
```

Training

```
filepath = dataset_path + "model_weights.h5"

checkpoint = ModelCheckpoint(filepath,
                             monitor="val_loss",
                             mode="min",
                             save_best_only = True,
                             verbose=1)

earlystop = EarlyStopping(monitor = 'val_loss',
                            mode="min",
                            min_delta = 0,
                            patience = 5,
                            verbose = 1,
                            restore_best_weights = True)

reduce_lr = ReduceLROnPlateau(monitor = 'val_loss', factor = 0.2, patience = 5, verbose


logdir = os.path.join('/logs/')
tensorboard_callback = tf.keras.callbacks.TensorBoard(logdir, histogram_freq=1)

callbacks = [checkpoint, earlystop , reduce_lr,tensorboard_callback]
```

```
history = model.fit(x = X_train, y = Y_train, batch_size = 32, validation_data=(X_test,
```

IOU Score Evaluation & Test Visualization

```
def IoU(y_val, y_pred):
    class_iou = []
    n_classes = 7

    y_predi = np.argmax(y_pred, axis=3)
    y_truei = np.argmax(y_val, axis=3)

    for c in range(n_classes):
        TP = np.sum((y_truei == c) & (y_predi == c))
        FP = np.sum((y_truei != c) & (y_predi == c))
        FN = np.sum((y_truei == c) & (y_predi != c))
        IoU = TP / float(TP + FP + FN)
        if(float(TP + FP + FN) == 0):
          IoU=TP/0.001
        class_iou.append(IoU)
    MIoU=sum(class_iou)/n_classes
    return MIoU

```

```
Y_pred = model.predict(X_test)
print('MIoU:',IoU(Y_test, Y_pred))
```

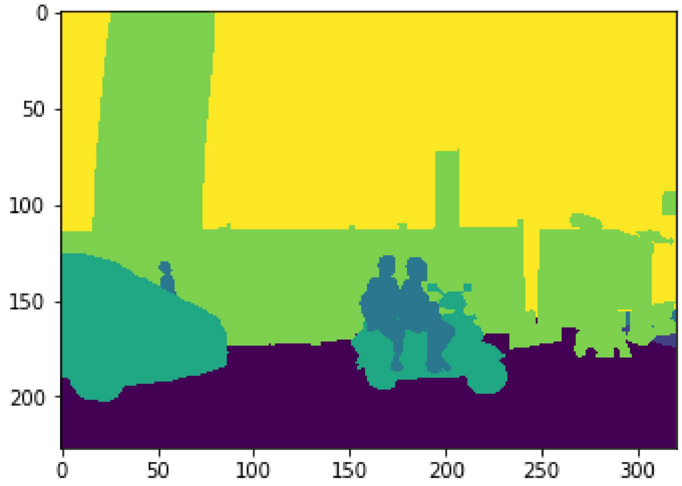
```
plt.imshow(X_test[3])
```

```
print(os. listdir('idd20k_lite/gtFine/train/0'))
print(os. listdir('idd20k_lite/leftImg8bit/train'))
print(os. listdir('idd20k_lite/leftImg8bit/train/0'))
```

```
['train', 'val']
['test', 'train', 'val']
['0', '0000002_inst_label.png', '0000002_label.png', '0000097_inst_label.png', '00000
['024541_inst_label.png', '024541_label.png', '024703_inst_label.png', '024703_label
['0', '0000002_image.jpg', '0000097_image.jpg', '0000192_image.jpg', '0000215_image.j
['024541_image.jpg', '024703_image.jpg']
```

```
dataset_path = 'idd20k_lite/'
img_train = dataset_path + 'leftImg8bit/train/'
seg_train = dataset_path + 'gtFine/train/'
img_val = dataset_path + 'leftImg8bit/val/'
seg_val = dataset_path + 'gtFine/val/'
img_test = dataset_path + 'leftImg8bit/test/'
```

```
VisSegmentation(seg_train+'0/024703_label.png')
```



```
imgage = cv2.imread(img_train+'0/024703_image.jpg',1)
plt.imshow(imgage)
```

```
<matplotlib.image.AxesImage at 0x23cc7446ef0>
```