

In []:

1

In []:

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

In [1]:

```
1 from keras.layers import Input, Dense, Flatten, Dropout
2 from keras.models import Model
3 from keras.optimizers import Adam, SGD
4 from keras.utils import np_utils
5 from keras import backend as K
6 import numpy as np
7 import os
8 from keras.regularizers import l2
9 import tensorflow as tf
10 import time
11 import datetime
12 import argparse
13 import datetime
14 import socket
15 import keras
16 from sklearn import preprocessing
17 import scipy.io as sio
18 import numpy as np
19 import matplotlib.pyplot as plt
20 from sklearn import preprocessing
21 import time
22 from keras.preprocessing.image import ImageDataGenerator
23 from PIL import Image, ImageOps
24 from keras.preprocessing import image
25 from keras.preprocessing.image import ImageDataGenerator
26 ##### For one-hot label
27 from keras.utils import np_utils
28
```

/root/anaconda3/lib/python3.6/site-packages/h5py/__init__.py:36: FutureWarning: Conversion of the second argument of issubdtype from `float` to `np.float` is deprecated. In future, it will be treated as `np.float64` = `np.dtype(float).type`.

from ._conv import register_converters as _register_converters
Using TensorFlow backend.

In [2]:

```
1 os.environ["CUDA_VISIBLE_DEVICES"]="0";
```

In [3]:

```
1 # pip install -U scikit-learn
2
```

```
In [ ]: 1 nb_classes = 397
        2 img_depth = 3
        3 data_dir = '/content/drive/My Drive/Colab Notebooks/SUN_Practice/'+'SUN39
        4 train_img_file = '/content/drive/My Drive/Colab Notebooks/SUN_Practice/F
        5 test_img_file = '/content/drive/My Drive/Colab Notebooks/SUN_Practice/Pa
        6 classes_name_list = '/content/drive/My Drive/Colab Notebooks/SUN_Practic
        7 train_label_file = '/content/drive/My Drive/Colab Notebooks/SUN_Practice/
        8 test_label_file = '/content/drive/My Drive/Colab Notebooks/SUN_Practice/
        9
        10 train_img_file_path='/content/drive/My Drive/Colab Notebooks/SUN_Practic
        11 test_img_file_path='/content/drive/My Drive/Colab Notebooks/SUN_Practice
        12
```

```
In [ ]: 1 print(train_img_file)
```

```
In [ ]: 1 print('Begin to create a map to transfer the str label to int label...')
        2 class_name_file = classes_name_list
        3 class_str = [str(line.strip()) for line in open(class_name_file).readlin
        4 class_count = len(class_str)
        5 print('%d class names are loaded' % class_count)
        6         # begin to create the map
        7 le = preprocessing.LabelEncoder()
        8 le.fit(class_str)
        9 print(list(le.classes_))
        10 print('Label map created...')
        11
```

```
In [ ]: 1 x_train=[]
        2
        3 x_test=[]
        4
        5 x_train = np.array(x_train)
        6
        7 x_test = np.array(x_test)
        8
```

```
In [ ]: 1 x_train.shape
```

load training data

```
In [ ]: 1 print('\nBegin to load training data...\n')
        2 desired_img_dim=224
        3 print('Loading image file %s' % train_img_file_path)
        4
```

```

In [ ]: 1 start_time_ = time.time()
        2 train_img_file_path = [str(line.strip()) for line in open(train_img_file
        3 nb_sample = len(train_img_file_path)
        4 print('Image count: %d' % nb_sample)
        5
        6 data_resized_holder = np.empty([nb_sample, desired_img_dim, desired_img_
        7
        8 for idx in range(nb_sample):
        9     img_file1 = train_img_file_path[idx].replace("\\", "/")      # the in
       10     # print(str(img_file1))
       11     # 1. read the image
       12     img1 = image.load_img(data_dir+img_file1)
       13
       14     # 2. resize
       15     img1 = img1.resize((desired_img_dim, desired_img_dim), resample=0)
       16
       17
       18     # 6. give to the holder
       19     data_resized_holder[idx] = img1
       20     if(idx % 1000==0):
       21         print('%d image loaded.' % idx)
       22
       23 print('\nImage file loaded, the shape is ' + str(data_resized_holder.sha
       24

```

```

In [ ]: 1 x_train.shape

```

loading the training labels text

```

In [ ]: 1 one_hot = True
        2 print('Loading label file %s' % train_label_file)
        3 label_str = [str(line.strip()) for line in open(train_label_file).readl
        4 nb_unique = len(label_str)
        5 labels_unique = le.transform(label_str)
        6 # print(labels_unique)
        7 labels_holder = np.hstack([ [ labels_unique[i] ] * 50 for i in range(nb
        8 # print(labels_holder)
        9 nb_sample = len(labels_holder)
       10 if one_hot == True:
       11     labels = np.array([[float(i == 1) for i in range(nb_classes)] for l
       12 else:
       13     labels = labels_holder
       14 print('Labels loaded, shape is:' + str(labels.shape))
       15
       16

```

loading training data

```

In [ ]: 1 x_train, nb_train_sample_1 = data_resized_holder, nb_sample

```

```

In [ ]: 1 y_train, nb_train_sample_2 = labels, nb_sample

```

```
In [ ]: 1 del data_resized_holder  
        2 del labels
```

```
In [ ]: 1 x_train.shape
```

```
In [ ]: 1 y_train.shape
```

Saving train data and test data

Saving x_train y_train as .npy file

```
In [ ]: 1 np.save('/content/drive/My Drive/Colab Notebooks/SUN_Practice/x_train.npy')
```

```
In [ ]: 1 np.save('/content/drive/My Drive/Colab Notebooks/SUN_Practice/y_train.npy')
```

```
In [ ]: 1 del x_train  
        2 #del y_train  
        3
```

loading testing data

load testing data

```

In [ ]: print('Loading image file %s' % test_img_file_path )
        start_time_ = time.time()
        test_img_file_path = [str(line.strip()) for line in open(test_img_file_path).readlines()]
        nb_sample = len(test_img_file_path)
        print('Image count: %d' % nb_sample)
        6
        data_resized_holder = np.empty([nb_sample, desired_img_dim, desired_img_dim, 3])
        8
        for idx in range(nb_sample):
            10 img_file1 = data_dir + test_img_file_path[idx].replace("\\", "/")      # test image file
            11 # print(str(img_file1))
            12 # 1. read the image
            13 img1 = image.load_img(img_file1)
            14
            15 # 2. resize
            16 img1 = img1.resize((desired_img_dim, desired_img_dim), resample=0)
            17
            18
            19 # 6. give to the holder
            20 data_resized_holder[idx] = img1
            21 if (idx % 1000 == 0):
            22     print('%d image loaded.' % idx)
            23
            24 print('\nImage file loaded, the shape is ' + str(data_resized_holder.shape))
            25
            26

```

Load test labels

```

In [ ]: 1 one_hot = True
        2 # loading the training labels
        3 print('Loading label file %s' % test_label_file)
        4 label_str = [str(line.strip()) for line in open(test_label_file).readlines()]
        5 nb_unique = len(label_str)
        6 labels_unique = le.transform(label_str)
        7 # print(labels_unique)
        8 labels_holder = np.hstack([ [ labels_unique[i] ] * 50 for i in range(nb_unique)])
        9 # print(labels_holder)
        10 nb_sample = len(labels_holder)
        11 if one_hot == True:
        12     labels = np.array([[float(i == 1) for i in range(nb_classes)] for l in range(nb_sample)])
        13 else:
        14     labels = labels_holder
        15 print('Labels loaded, shape is:' + str(labels.shape))
        16
        17

```

```

In [ ]: 1 x_test, nb_test_sample_1 = data_resized_holder, nb_sample

```

```

In [ ]: 1 y_test, nb_test_sample_2 = labels, nb_sample

```

```
In [ ]: 1 del data_resized_holder
        2 del labels
```

Saving x_test y_test .npy file

```
In [ ]: 1 np.save('/content/drive/My Drive/Colab Notebooks/SUN_Practice/x_test.npy')
```

```
In [ ]: 1 np.save('/content/drive/My Drive/Colab Notebooks/SUN_Practice/y_test.npy')
```

```
In [ ]: 1 del x_test
        2 del y_test
```

```
In [ ]: 1 y_test.shape
```

```
1 # **Load train data and test data**
```

Load train data

```
In [4]: 1 x_train = np.load('/root/Code_GCP/SUN_Practice/x_train.npy')
```

```
In [5]: 1 y_train = np.load('/root/Code_GCP/SUN_Practice/y_train.npy')
```

```
In [6]: 1 x_train.shape
```

```
Out[6]: (19850, 224, 224, 3)
```

```
In [7]: 1 print(y_train.shape)
```

```
(19850, 397)
```

Load test data

```
In [8]: 1 x_test = np.load('/root/Code_GCP/SUN_Practice/x_test.npy')
```

```
In [9]: 1 y_test = np.load('/root/Code_GCP/SUN_Practice/y_test.npy')
```

```
In [10]: 1 print(x_train.shape)
        2 print(y_train.shape)
        3 print(x_test.shape)
        4 print(y_test.shape)
```

```
(19850, 224, 224, 3)
```

```
(19850, 397)
```

```
(19850, 224, 224, 3)
```

```
(19850, 397)
```

```
In [11]: 1  !/opt/bin/nvidia-smi

/bin/sh: 1: /opt/bin/nvidia-smi: not found
```

Data Augmentation

```
In [ ]: 1  generator = ImageDataGenerator(
2          rotation_range=40,
3          width_shift_range=0.2,
4          height_shift_range=0.2,
5          shear_range=0.2,
6          zoom_range=0.2,
7          horizontal_flip=True,
8          fill_mode='nearest')
9
```

Set data to one-hot encoded format (vector of 397 class binary values)

```
In [ ]: 1  # import keras
2
3  # y_train = keras.utils.to_categorical(y_train, 397)
4  # y_test = keras.utils.to_categorical(y_test, 397)
```

```
In [12]: 1  from tensorflow.keras.applications.vgg16 import preprocess_input
2
3  x_train = preprocess_input(x_train)
4  x_test = preprocess_input(x_test)
5  # x_train /= 255
6  # x_test /= 255
```

```
In [ ]: 1  y_train.shape
```

Using VGG16 Pre-trained model based imagenet train this dataset

```
In [13]: 1  import os
2  import keras
3  from keras.models import Model
4  from keras.layers import Dense, Flatten, Dropout
5  from keras import datasets
6  from keras.applications.vgg16 import VGG16
7  #from vgg16_places_365 import VGG16_Places365
8  from keras.optimizers import SGD, Adam
9  from keras import optimizers
10 from keras.callbacks import EarlyStopping
11
```

In [14]:

```
1 dim=224  
2 num_classes=397
```



```

In [15]: 1 model_sun_vgg = VGG16(include_top=False, weights='imagenet', input_shape=(224, 224, 3))
2
3 for layer in model_sun_vgg.layers:
4     layer.trainable = False
5
6 model = Flatten()(model_sun_vgg.output)
7 # model.add(layers.BatchNormalization())
8 #keras.layers.normalization.BatchNormalization(axis=-1, momentum=0.99, epsilon=1e-5)
9 model = Dense(4096, activation="relu")(model)
10 model = Dense(1000, activation="relu")(model)
11 model = Dense(1000, activation="relu")(model)
12 model = Dropout(0.3)(model)
13 model = Dense(num_classes, activation="softmax")(model)
14 model_pretrain_vgg = Model(model_sun_vgg.input, model, name='model_pretrain_vgg')
15 model_pretrain_vgg.summary()
16
17

```

Layer (type)	Output Shape	Param #
=====		
input_1 (InputLayer)	(None, 224, 224, 3)	0
block1_conv1 (Conv2D)	(None, 224, 224, 64)	1792
block1_conv2 (Conv2D)	(None, 224, 224, 64)	36928
block1_pool (MaxPooling2D)	(None, 112, 112, 64)	0
block2_conv1 (Conv2D)	(None, 112, 112, 128)	73856
block2_conv2 (Conv2D)	(None, 112, 112, 128)	147584
block2_pool (MaxPooling2D)	(None, 56, 56, 128)	0
block3_conv1 (Conv2D)	(None, 56, 56, 256)	295168
block3_conv2 (Conv2D)	(None, 56, 56, 256)	590080
block3_conv3 (Conv2D)	(None, 56, 56, 256)	590080
block3_pool (MaxPooling2D)	(None, 28, 28, 256)	0
block4_conv1 (Conv2D)	(None, 28, 28, 512)	1180160
block4_conv2 (Conv2D)	(None, 28, 28, 512)	2359808
block4_conv3 (Conv2D)	(None, 28, 28, 512)	2359808
block4_pool (MaxPooling2D)	(None, 14, 14, 512)	0
block5_conv1 (Conv2D)	(None, 14, 14, 512)	2359808
block5_conv2 (Conv2D)	(None, 14, 14, 512)	2359808
block5_conv3 (Conv2D)	(None, 14, 14, 512)	2359808

block5_pool (MaxPooling2D)	(None, 7, 7, 512)	0
flatten_1 (Flatten)	(None, 25088)	0
dense_1 (Dense)	(None, 4096)	102764544
dense_2 (Dense)	(None, 1000)	4097000
dense_3 (Dense)	(None, 1000)	1001000
dropout_1 (Dropout)	(None, 1000)	0
dense_4 (Dense)	(None, 397)	397397
=====		
Total params: 122,974,629		
Trainable params: 108,259,941		
Non-trainable params: 14,714,688		

```
In [16]: 1 from keras import optimizers
          2 from keras.callbacks import EarlyStopping
          3
```

```
In [17]: 1 def learning_rate_schedule(epoch):
          2     if epoch <= 10:
          3         return 1e-4 # 0.00001
          4     elif epoch <= 20:
          5         return 1e-5
          6     elif epoch <= 30:
          7         return 1e-6
          8     else:
          9         return 1e-7
         10     return LR
```

```
In [18]: 1 #learning_rate = 0.05
          2 # batch_size=64
          3 # Epoch = 10
          4 # decay_rate = learning_rate / Epoch
          5 # momentum = 0.9
          6 # #sgd = SGD(lr=learning_rate, momentum=momentum, decay=decay_rate, nes
          7 # # sgd=SGD(lr=0.05,decay=1e-5)
          8 # #opt= Adam(lr=0.01)
          9
```

```
In [19]: 1 model_pretrain_vgg.save_weights('model_sun_initial.h5')
```

```

In [20]: batch_size = 128
training_runs = []
for i in range(3):
    #model_updated.compile(loss='categorical_crossentropy', optimizer='sgd
    5
    6
    7 model_pretrain_vgg.compile(loss='mean_squared_error', optimizer=optimi
    8 keras.callbacks.LearningRateScheduler(learning_rate_schedule)
    9
    10# history = model_pretrain_vgg.fit_generator(generator.flow(x_train, y
    11# steps_per_epoch=len(x_train) / batch_size,
    12# epochs=10,
    13# verbose=1,
    14# shuffle=True ,
    15# validation_data=(x_test, y_test))
    16 history = model_pretrain_vgg.fit(
    17 x_train, y_train,
    18 batch_size=128, shuffle=True, epochs=10,
    19 validation_data=(x_test, y_test)
    20 )
    21
    22
    23 training_runs.append(history)
    24 model_pretrain_vgg.get_weights()
    25 if i == 2:
    26     model_pretrain_vgg.save_weights('model1.h5')
    27 else:
    28     model_pretrain_vgg.load_weights('model_sun_initial.h5')
    29 print()

```

Train on 19850 samples, validate on 19850 samples

Epoch 1/10

19850/19850 [=====] - 279s 14ms/step - loss: 0.0033 - acc: 0.0037 - val_loss: 0.0025 - val_acc: 0.0039

Epoch 2/10

19850/19850 [=====] - 247s 12ms/step - loss: 0.0025 - acc: 0.0059 - val_loss: 0.0025 - val_acc: 0.0047

Epoch 3/10

19850/19850 [=====] - 247s 12ms/step - loss: 0.0025 - acc: 0.0121 - val_loss: 0.0025 - val_acc: 0.0097

Epoch 4/10

19850/19850 [=====] - 248s 12ms/step - loss: 0.0025 - acc: 0.0214 - val_loss: 0.0025 - val_acc: 0.0191

Epoch 5/10

19850/19850 [=====] - 248s 13ms/step - loss: 0.0025 - acc: 0.0355 - val_loss: 0.0025 - val_acc: 0.0364

Epoch 6/10

19850/19850 [=====] - 249s 13ms/step - loss: 0.0024 - acc: 0.0555 - val_loss: 0.0025 - val_acc: 0.0493

Epoch 7/10

19850/19850 [=====] - 248s 12ms/step - loss: 0.0024 - acc: 0.0691 - val_loss: 0.0024 - val_acc: 0.0656

Epoch 8/10

19850/19850 [=====] - 248s 13ms/step - loss: 0.0024 - acc: 0.1012 - val_loss: 0.0024 - val_acc: 0.0866

Epoch 9/10

```
19850/19850 [=====] - 248s 13ms/step - loss: 0.0
023 - acc: 0.1351 - val_loss: 0.0024 - val_acc: 0.1077
Epoch 10/10
19850/19850 [=====] - 248s 13ms/step - loss: 0.0
022 - acc: 0.1662 - val_loss: 0.0024 - val_acc: 0.1280

Train on 19850 samples, validate on 19850 samples
Epoch 1/10
19850/19850 [=====] - 256s 13ms/step - loss: 0.0
035 - acc: 0.0030 - val_loss: 0.0025 - val_acc: 0.0036
Epoch 2/10
19850/19850 [=====] - 246s 12ms/step - loss: 0.0
025 - acc: 0.0054 - val_loss: 0.0025 - val_acc: 0.0040
Epoch 3/10
19850/19850 [=====] - 246s 12ms/step - loss: 0.0
025 - acc: 0.0103 - val_loss: 0.0025 - val_acc: 0.0072
Epoch 4/10
19850/19850 [=====] - 247s 12ms/step - loss: 0.0
025 - acc: 0.0173 - val_loss: 0.0025 - val_acc: 0.0156
Epoch 5/10
19850/19850 [=====] - 248s 12ms/step - loss: 0.0
025 - acc: 0.0306 - val_loss: 0.0025 - val_acc: 0.0326
Epoch 6/10
19850/19850 [=====] - 249s 13ms/step - loss: 0.0
025 - acc: 0.0481 - val_loss: 0.0025 - val_acc: 0.0453
Epoch 7/10
19850/19850 [=====] - 249s 13ms/step - loss: 0.0
024 - acc: 0.0664 - val_loss: 0.0025 - val_acc: 0.0559
Epoch 8/10
19850/19850 [=====] - 249s 13ms/step - loss: 0.0
024 - acc: 0.0834 - val_loss: 0.0024 - val_acc: 0.0698
Epoch 9/10
19850/19850 [=====] - 249s 13ms/step - loss: 0.0
023 - acc: 0.1081 - val_loss: 0.0024 - val_acc: 0.0903
Epoch 10/10
19850/19850 [=====] - 249s 13ms/step - loss: 0.0
023 - acc: 0.1324 - val_loss: 0.0024 - val_acc: 0.1041

Train on 19850 samples, validate on 19850 samples
Epoch 1/10
19850/19850 [=====] - 254s 13ms/step - loss: 0.0
034 - acc: 0.0029 - val_loss: 0.0025 - val_acc: 0.0024
Epoch 2/10
19850/19850 [=====] - 246s 12ms/step - loss: 0.0
025 - acc: 0.0040 - val_loss: 0.0025 - val_acc: 0.0039
Epoch 3/10
19850/19850 [=====] - 247s 12ms/step - loss: 0.0
025 - acc: 0.0085 - val_loss: 0.0025 - val_acc: 0.0057
Epoch 4/10
19850/19850 [=====] - 248s 12ms/step - loss: 0.0
025 - acc: 0.0154 - val_loss: 0.0025 - val_acc: 0.0148
Epoch 5/10
19850/19850 [=====] - 248s 12ms/step - loss: 0.0
025 - acc: 0.0274 - val_loss: 0.0025 - val_acc: 0.0240
Epoch 6/10
19850/19850 [=====] - 247s 12ms/step - loss: 0.0
025 - acc: 0.0406 - val_loss: 0.0025 - val_acc: 0.0377
```

```
Epoch 7/10
19850/19850 [=====] - 247s 12ms/step - loss: 0.0
024 - acc: 0.0524 - val_loss: 0.0025 - val_acc: 0.0483
Epoch 8/10
19850/19850 [=====] - 247s 12ms/step - loss: 0.0
024 - acc: 0.0733 - val_loss: 0.0024 - val_acc: 0.0654
Epoch 9/10
19850/19850 [=====] - 248s 13ms/step - loss: 0.0
024 - acc: 0.0973 - val_loss: 0.0024 - val_acc: 0.0823
Epoch 10/10
19850/19850 [=====] - 249s 13ms/step - loss: 0.0
023 - acc: 0.1201 - val_loss: 0.0024 - val_acc: 0.0970
```

```
In [21]: 1 import tensorflow as tf
         2 #sess = tf.Session(config=tf.ConfigProto(log_device_placement=True))
         3 tf.__version__
         4 tf.test.is_gpu_available()
```

Out[21]: True

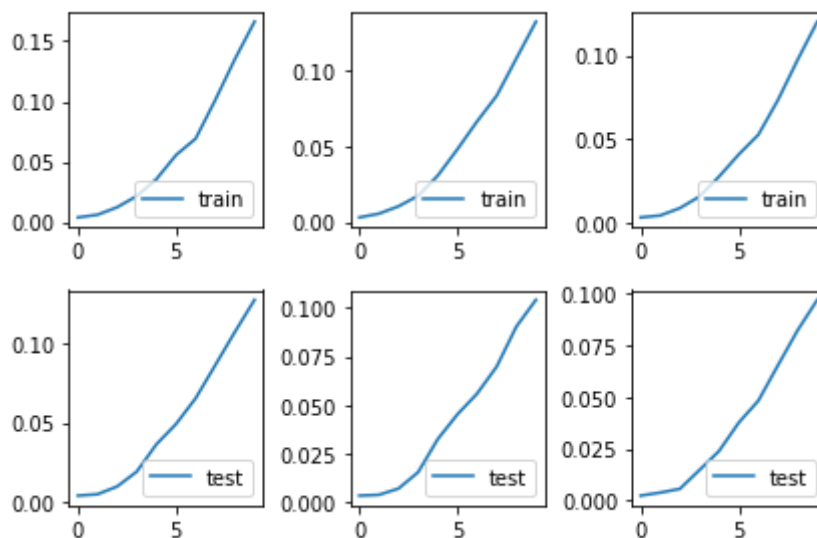
```
In [ ]: 1
```

```
In [22]: 1 #hist = pretrain_model.fit(x_train, y_train, validation_data = (x_test,
```

```

In [23]: 1 import matplotlib.pyplot as plt
2 import numpy as np
3
4 plt.subplot(2, 3, 1)
5 plt.plot(training_runs[0].history['acc'])
6 plt.legend(['train'], loc='lower right')
7
8 plt.subplot(2, 3, 2)
9 plt.plot(training_runs[1].history['acc'])
10 plt.legend(['train'], loc='lower right')
11
12 plt.subplot(2, 3, 3)
13 plt.plot(training_runs[2].history['acc'])
14 plt.legend(['train'], loc='lower right')
15
16 plt.subplot(2, 3, 4)
17 plt.plot(training_runs[0].history['val_acc'])
18 plt.legend(['test'], loc='lower right')
19
20 plt.subplot(2, 3, 5)
21 plt.plot(training_runs[1].history['val_acc'])
22 plt.legend(['test'], loc='lower right')
23
24 plt.subplot(2, 3, 6)
25 plt.plot(training_runs[2].history['val_acc'])
26 plt.legend(['test'], loc='lower right')
27
28 plt.tight_layout()
29
30 plt.show()
31
32

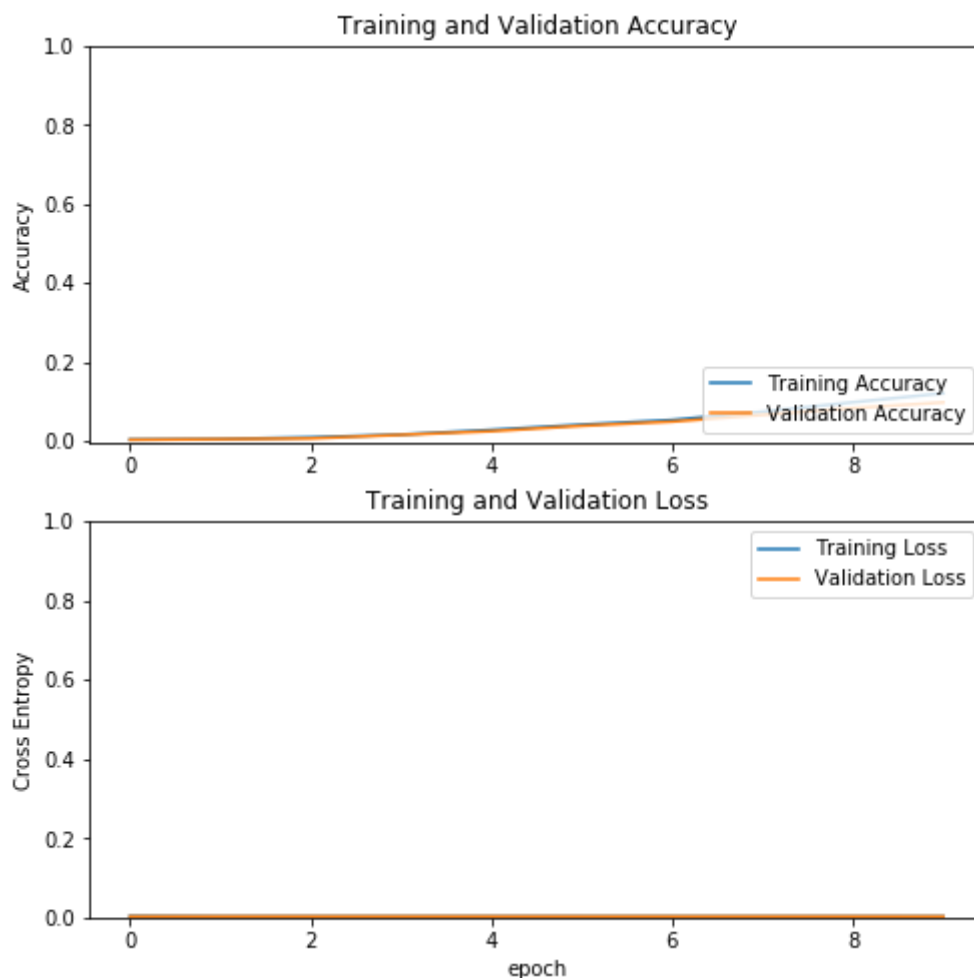
```



```

In [26]: 1 acc = history.history['acc']
          2 val_acc = history.history['val_acc']
          3
          4 loss = history.history['loss']
          5 val_loss = history.history['val_loss']
          6
          7 plt.figure(figsize=(8, 8))
          8 plt.subplot(2, 1, 1)
          9 plt.plot(acc, label='Training Accuracy')
         10 plt.plot(val_acc, label='Validation Accuracy')
         11 plt.legend(loc='lower right')
         12 plt.ylabel('Accuracy')
         13 plt.ylim([min(plt.ylim()), 1])
         14 plt.title('Training and Validation Accuracy')
         15
         16 plt.subplot(2, 1, 2)
         17 plt.plot(loss, label='Training Loss')
         18 plt.plot(val_loss, label='Validation Loss')
         19 plt.legend(loc='upper right')
         20 plt.ylabel('Cross Entropy')
         21 plt.ylim([0, 1.0])
         22 plt.title('Training and Validation Loss')
         23 plt.xlabel('epoch')
         24 plt.show()

```



```
In [27]: e training accuracy: {}".format(np.mean([training_runs[0].history['acc'][-1],
2                                         training_runs[1].history['acc'][-1],
e testing accuracy: {}".format(np.mean([training_runs[0].history['val_acc'][-1],
4                                         training_runs[1].history['val_acc'][-1]
```

Average training accuracy: 0.1395801847192242

Average testing accuracy: 0.10967254408060452

```
In [ ]: 1 # loss, accuracy = model.evaluate(x_test, y_test, verbose=0)
2 # print('Test loss:', loss)
3 # print('Test accuracy:', accuracy)
```

VGG16 Pre-trian model based on Places365

```
In [49]: 1 import vgg16_places_365
```

```
In [50]: 1 from keras import backend as K
2 from keras.layers import Input
3 from keras.layers.core import Activation, Dense, Flatten
4 from keras.layers.pooling import MaxPooling2D
5 from keras.models import Model
6 from keras.layers import Conv2D
7 from keras.regularizers import l2
8 from keras.layers.core import Dropout
9 from keras.layers import GlobalAveragePooling2D
10 from keras.layers import GlobalMaxPooling2D
11 from keras_applications.imagenet_utils import _obtain_input_shape
12 from keras.engine.topology import get_source_inputs
13 from keras.utils.data_utils import get_file
14 from keras.utils import layer_utils
15 from keras.preprocessing import image
16 from keras.applications.imagenet_utils import preprocess_input
17 from urllib.request import urlopen
18 import numpy as np
19 from PIL import Image
20 from cv2 import resize
```

```
In [51]: 1 WEIGHTS_PATH = 'https://github.com/GKalliatakis/Keras-VGG16-places365/re
2 WEIGHTS_PATH_NO_TOP = 'https://github.com/GKalliatakis/Keras-VGG16-place
3
```

```
In [52]: 1 from vgg16_places_365 import VGG16_Places365
```



```
In [53]: 1 model_places365 = VGG16_Places365(include_top=False,  
2                                           weights='places',  
3                                           input_tensor=None,  
4                                           input_shape=(224,224,3),  
5                                           pooling=None,  
6                                           classes=365  
7                                           )  
8
```

In [54]: 1 model_places365.summary()

Layer (type)	Output Shape	Param #
=====		
input_4 (InputLayer)	(None, 224, 224, 3)	0
block1_conv1 (Conv2D)	(None, 224, 224, 64)	1792
block1_conv2 (Conv2D)	(None, 224, 224, 64)	36928
block1_pool (MaxPooling2D)	(None, 112, 112, 64)	0
block2_conv1 (Conv2D)	(None, 112, 112, 128)	73856
block2_conv2 (Conv2D)	(None, 112, 112, 128)	147584
block2_pool (MaxPooling2D)	(None, 56, 56, 128)	0
block3_conv1 (Conv2D)	(None, 56, 56, 256)	295168
block3_conv2 (Conv2D)	(None, 56, 56, 256)	590080
block3_conv3 (Conv2D)	(None, 56, 56, 256)	590080
block3_pool (MaxPooling2D)	(None, 28, 28, 256)	0
block4_conv1 (Conv2D)	(None, 28, 28, 512)	1180160
block4_conv2 (Conv2D)	(None, 28, 28, 512)	2359808
block4_conv3 (Conv2D)	(None, 28, 28, 512)	2359808
block4_pool (MaxPooling2D)	(None, 14, 14, 512)	0
block5_conv1 (Conv2D)	(None, 14, 14, 512)	2359808
block5_conv2 (Conv2D)	(None, 14, 14, 512)	2359808
block5_conv3 (Conv2D)	(None, 14, 14, 512)	2359808
block5_pool (MaxPooling2D)	(None, 7, 7, 512)	0
=====		
Total params: 14,714,688		
Trainable params: 14,714,688		
Non-trainable params: 0		

```

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```

dense_13 (Dense)	(None, 4096)	102764544
dense_14 (Dense)	(None, 1000)	4097000
dense_15 (Dense)	(None, 1000)	1001000
dropout_4 (Dropout)	(None, 1000)	0
dense_16 (Dense)	(None, 397)	397397
=====		
Total params: 122,974,629		
Trainable params: 108,259,941		
Non-trainable params: 14,714,688		
=====		

```
In [56]: 1 from keras import optimizers
          2 from keras.callbacks import EarlyStopping
          3
```

```
In [57]: 1 def learning_rate_schedule(epoch):
          2     if epoch <= 10:
          3         return 1e-4 # 0.00001
          4     elif epoch <= 20:
          5         return 1e-5
          6     elif epoch <= 30:
          7         return 1e-6
          8     else:
          9         return 1e-7
         10     return LR
```

```
In [58]: 1 model_pretrain_vgg_places.save_weights('model_sun_places_initial.h5')
```

```

In [60]: 1 #batch_size = 128
2 training_runs = []
3 for i in range(3):
4     #model_updated.compile(loss='categorical_crossentropy', optimizer='s
5
6
7     model_pretrain_vgg_places.compile(loss='mean_squared_error', optimiz
8     keras.callbacks.LearningRateScheduler(learning_rate_schedule)
9
10    #     history = model_pretrain_vgg.fit_generator(generator.flow(x_train,
11    #     steps_per_epoch=len(x_train) / batch_size,
12    #     epochs=10,
13    #     verbose=1,
14    #     shuffle=True ,
15    #     validation_data=(x_test, y_test))
16    history = model_pretrain_vgg_places.fit(
17    x_train, y_train,
18    batch_size=128, shuffle=True, epochs=10,
19    validation_data=(x_test, y_test)
20    )
21
22
23    training_runs.append(history)
24    model_pretrain_vgg_places.get_weights()
25    if i == 2:
26        model_pretrain_vgg_places.save_weights('model1_places.h5')
27    else:
28        model_pretrain_vgg_places.load_weights('model_sun_places_initial
29    print()

```

Train on 19850 samples, validate on 19850 samples

Epoch 1/10

```

-----
--
ResourceExhaustedError                                Traceback (most recent call las
t)
<ipython-input-60-af8c9a49e812> in <module>()
    17     x_train, y_train,
    18     batch_size=128, shuffle=True, epochs=10,
--> 19     validation_data=(x_test, y_test)
    20 )
    21

~/anaconda3/lib/python3.6/site-packages/keras/engine/training.py in fit(s
elf, x, y, batch_size, epochs, verbose, callbacks, validation_split, vali
dation_data, shuffle, class_weight, sample_weight, initial_epoch, steps_p
er_epoch, validation_steps, **kwargs)
    1035                                     initial_epoch=initial_epo
ch,
    1036                                     steps_per_epoch=steps_per
_epoch,
-> 1037                                     validation_steps=validati
on_steps)
    1038
    1039     def evaluate(self, x=None, y=None,

```

```
~/anaconda3/lib/python3.6/site-packages/keras/engine/training_arrays.py in
n fit_loop(model, f, ins, out_labels, batch_size, epochs, verbose, callba
cks, val_f, val_ins, shuffle, callback_metrics, initial_epoch, steps_per_
epoch, validation_steps)
    197             ins_batch[i] = ins_batch[i].toarray()
    198
--> 199             outs = f(ins_batch)
    200             outs = to_list(outs)
    201             for l, o in zip(out_labels, outs):

~/anaconda3/lib/python3.6/site-packages/keras/backend/tensorflow_backend.
py in __call__(self, inputs)
    2664             return self._legacy_call(inputs)
    2665
-> 2666             return self._call(inputs)
    2667         else:
    2668             if py_any(is_tensor(x) for x in inputs):

~/anaconda3/lib/python3.6/site-packages/keras/backend/tensorflow_backend.
py in _call(self, inputs)
    2634             symbol_vals,
    2635             session)
-> 2636         fetched = self._callable_fn(*array_vals)
    2637         return fetched[:len(self.outputs)]
    2638

~/anaconda3/lib/python3.6/site-packages/tensorflow/python/client/session.
py in __call__(self, *args, **kwargs)
    1380         ret = tf_session.TF_SessionRunCallable(
    1381             self._session._session, self._handle, args, status,
-> 1382             run_metadata_ptr)
    1383         if run_metadata:
    1384             proto_data = tf_session.TF_GetBuffer(run_metadata_ptr)

~/anaconda3/lib/python3.6/site-packages/tensorflow/python/framework/error
s_impl.py in __exit__(self, type_arg, value_arg, traceback_arg)
    517             None, None,
    518             compat.as_text(c_api.TF_Message(self.status.status)),
--> 519             c_api.TF_GetCode(self.status.status))
    520         # Delete the underlying status object from memory otherwise i
t stays alive
    521         # as there is a reference to status from this from the traceb
ack due to

ResourceExhaustedError: OOM when allocating tensor with shape[3,3,512,51
2] and type float on /job:localhost/replica:0/task:0/device:GPU:0 by allo
cator GPU_0_bfc
[[Node: block5_conv1_3/weight_regularizer/Square = Square[T=DT_F
LOAT, _device="/job:localhost/replica:0/task:0/device:GPU:0"] (block5_conv
1_3/kernel/read)]]
Hint: If you want to see a list of allocated tensors when OOM happens, ad
d report_tensor_allocations_upon_oom to RunOptions for current allocation
info.

[[Node: loss_8/add_12/_2217 = _Recv[client_terminated=false, rec
v_device="/job:localhost/replica:0/task:0/device:CPU:0", send_device="/jo
b:localhost/replica:0/task:0/device:GPU:0", send_device_incarnation=1, te
```

```
nsor_name="edge_859_loss_8/add_12", tensor_type=DT_FLOAT, _device="/job:localhost/replica:0/task:0/device:CPU:0"]())]
```

Hint: If you want to see a list of allocated tensors when OOM happens, add `report_tensor_allocations_upon_oom` to `RunOptions` for current allocation info.

```
In [ ]: 1 import matplotlib.pyplot as plt
        2 import numpy as np
        3
        4 plt.subplot(2, 3, 1)
        5 plt.plot(training_runs[0].history['acc'])
        6 plt.legend(['train'], loc='lower right')
        7
        8 plt.subplot(2, 3, 2)
        9 plt.plot(training_runs[1].history['acc'])
       10 plt.legend(['train'], loc='lower right')
       11
       12 plt.subplot(2, 3, 3)
       13 plt.plot(training_runs[2].history['acc'])
       14 plt.legend(['train'], loc='lower right')
       15
       16 plt.subplot(2, 3, 4)
       17 plt.plot(training_runs[0].history['val_acc'])
       18 plt.legend(['test'], loc='lower right')
       19
       20 plt.subplot(2, 3, 5)
       21 plt.plot(training_runs[1].history['val_acc'])
       22 plt.legend(['test'], loc='lower right')
       23
       24 plt.subplot(2, 3, 6)
       25 plt.plot(training_runs[2].history['val_acc'])
       26 plt.legend(['test'], loc='lower right')
       27
       28 plt.tight_layout()
       29
       30 plt.show()
       31
       32
```

```
In [ ]: 1 acc = history.history['accuracy']
2 val_acc = history.history['val_accuracy']
3
4 loss = history.history['loss']
5 val_loss = history.history['val_loss']
6
7 plt.figure(figsize=(8, 8))
8 plt.subplot(2, 1, 1)
9 plt.plot(acc, label='Training Accuracy')
10 plt.plot(val_acc, label='Validation Accuracy')
11 plt.legend(loc='lower right')
12 plt.ylabel('Accuracy')
13 plt.ylim([min(plt.ylim()), 1])
14 plt.title('Training and Validation Accuracy')
15
16 plt.subplot(2, 1, 2)
17 plt.plot(loss, label='Training Loss')
18 plt.plot(val_loss, label='Validation Loss')
19 plt.legend(loc='upper right')
20 plt.ylabel('Cross Entropy')
21 plt.ylim([0, 1.0])
22 plt.title('Training and Validation Loss')
23 plt.xlabel('epoch')
24 plt.show()
```

```
In [ ]: 1 print("Average training accuracy: {}".format(np.mean([training_runs[0].h
2                                     training_runs[1].h
3 print("Average testing accuracy: {}".format(np.mean([training_runs[0].h
4                                     training_runs[1].h
```

```
In [ ]: 1 loss, accuracy = model.evaluate(x_test, y_test, verbose=0)
2 print('Test loss:', loss)
3 print('Test accuracy:', accuracy)
```

New Section