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Tensorflow之Debug

参考资料:https://wookayin.github.io/tensorflow-talk-debugging

几种常用方法:

1.通过Session.run()获取变量的值

2.利用Tensorboard查看一些可视化统计

3.使用tf.Print()和tf.Assert()打印变量

4.使用Python的debug工具: ipdb, pudb

5.利用tf.py_func()向图中插入自定义的打印代码, tdb

6.使用官方debug工具: tfdbg

复习:

tensorflow是通过先建图再运行的方式进行运行,这就使得我们写在图建立过程中的输出语句在图运行的时候并不能得到执行,从而使得调试困难. 我们想在运行过程中,对训练的一些变量进行追踪和打印,对一些错误进行输出分析,下面介绍几种在tensorflow中进行debug的方法.

详细介绍:

1.通过Session.run()获取变量的值

一个简单的例子:

```
x = tf.placeholder(tf.float32)
y = tf.placeholder(tf.float32)
bias = tf.Variable(1.0)

y_pred = x ** 2 + bias     # x -> x^2 + bias
loss = (y - y_pred)**2     # l2 loss?

# Error: to compute loss, y is required as a dependency
print('Loss(x,y) = %.3f' % session.run(loss, {x: 3.0}))

# OK, print 1.000 = (3**2 + 1 - 9)**2
print('Loss(x,y) = %.3f' % session.run(loss, {x: 3.0, y: 9.0}))

# OK, print 10.000; for evaluating y_pred only, input to y is not required
print('pred_y(x) = %.3f' % session.run(y_pred, {x: 3.0}))

# OK, print 1.000 bias evaluates to 1.0
print('bias      = %.3f' % session.run(bias))
```

优点:简单易行

缺点:必须要在图中保持需要观察的变量,必须要进行一次完整的运行

比如我们要获取各个层的输出,会变得很繁琐:

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```
def alexnet(x):
    assert x.get_shape().as_list() == [224, 224, 3]
    conv1 = conv_2d(x, 96, 11, strides=4, activation='relu')
    pool1 = max_pool_2d(conv1, 3, strides=2)
    conv2 = conv_2d(pool1, 256, 5, activation='relu')
    pool2 = max_pool_2d(conv2, 3, strides=2)
    conv3 = conv_2d(pool2, 384, 3, activation='relu')
    conv4 = conv_2d(conv3, 384, 3, activation='relu')
    conv5 = conv_2d(conv4, 256, 3, activation='relu')
    pool5 = max_pool_2d(conv5, 3, strides=2)
    fc6 = fully_connected(pool5, 4096, activation='relu')
    fc7 = fully_connected(fc6, 4096, activation='relu')
    output = fully_connected(fc7, 1000, activation='softmax')
    return conv1, pool1, conv2, pool2, conv3, conv4, conv5, pool5, fc6, fc7

conv1, conv2, conv3, conv4, conv5, fc6, fc7, output = alexnet(images)  # ?!
```

```
_, loss_, conv1_, conv2_, conv3_, conv4_, conv5_, fc6_, fc7_ = session.run(
        [train_op, loss, conv1, conv2, conv3, conv4, conv5, fc6, fc7],
        feed_dict = {...})
```

可以通过词典或者新建一个类来改善这一情况:

词典:

```
def alexnet(x, net={}):
    assert x.get_shape().as_list() == [224, 224, 3]
    net['conv1'] = conv_2d(x, 96, 11, strides=4, activation='relu')
    net['pool1'] = max_pool_2d(net['conv1'], 3, strides=2)
    net['conv2'] = conv_2d(net['pool1'], 256, 5, activation='relu')
    net['pool2'] = max_pool_2d(net['conv2'], 3, strides=2)
    net['conv3'] = conv_2d(net['pool2'], 384, 3, activation='relu')
    net['conv4'] = conv_2d(net['conv3'], 384, 3, activation='relu')
    net['conv5'] = conv_2d(net['conv4'], 256, 3, activation='relu')
    net['pool5'] = max_pool_2d(net['conv5'], 3, strides=2)
    net['fc6'] = fully_connected(net['pool5'], 4096, activation='relu')
    net['fc7'] = fully_connected(net['fc6'], 4096, activation='relu')
    net['output'] = fully_connected(net['fc7'], 1000, activation='softmax')
    return net['output']

net = {}
output = alexnet(images, net)
# access intermediate layers like net['conv5'], net['fc7'], etc.
```

类:

```
class AlexNetModel():
    # ...
    def build_model(self, x):
        assert x.get_shape().as_list() == [224, 224, 3]
        self.conv1 = conv_2d(x, 96, 11, strides=4, activation='relu')
        self.pool1 = max_pool_2d(self.conv1, 3, strides=2)
        self.conv2 = conv_2d(self.pool1, 256, 5, activation='relu')
        self.pool2 = max_pool_2d(self.conv2, 3, strides=2)
        self.conv3 = conv_2d(self.pool2, 384, 3, activation='relu')
        self.conv4 = conv_2d(self.conv3, 384, 3, activation='relu')
        self.conv5 = conv_2d(self.conv4, 256, 3, activation='relu')
        self.pool5 = max_pool_2d(self.conv5, 3, strides=2)
        self.fc6 = fully_connected(self.pool5, 4096, activation='relu')
        self.fc7 = fully_connected(self.fc6, 4096, activation='relu')
        self.output = fully_connected(self.fc7, 1000, activation='softmax')
        return self.output

model = AlexNetModel()
output = model.build_model(images)
# access intermediate layers like self.conv5, self.fc7, etc.
```

2.利用Tensorboard查看一些可视化统计

3.使用tf.Print()和tf.Assert()打印变量

```
tf.Print(input, data, message=None,
         first_n=None, summarize=None, name=None)
```

一个简单例子:

```
def multilayer_perceptron(x):
    fc1 = layers.fully_connected(x, 256, activation_fn=tf.nn.relu)
    fc2 = layers.fully_connected(fc1, 256, activation_fn=tf.nn.relu)
    out = layers.fully_connected(fc2, 10, activation_fn=None)
    out = tf.Print(out, [tf.argmax(out, 1)],
                   'argmax(out) = ', summarize=20, first_n=7)
    return out
```

在前7次迭代中,它会输出预测的label,如下图所示:

```
I tensorflow/core/kernels/logging_ops.cc:79] argmax(out) = [6 6 6 4 4 6 4 4 6 6 4 0 6 4
I tensorflow/core/kernels/logging_ops.cc:79] argmax(out) = [6 6 0 0 3 6 4 3 6 6 3 4 4 4
I tensorflow/core/kernels/logging_ops.cc:79] argmax(out) = [3 4 0 6 6 6 0 7 3 0 6 7 3 6
I tensorflow/core/kernels/logging_ops.cc:79] argmax(out) = [6 1 0 0 0 3 3 7 0 8 1 2 0 9
I tensorflow/core/kernels/logging_ops.cc:79] argmax(out) = [6 0 0 9 0 4 9 9 0 8 2 7 3 9
I tensorflow/core/kernels/logging_ops.cc:79] argmax(out) = [6 0 1 1 9 0 8 3 0 9 9 0 2 6
I tensorflow/core/kernels/logging_ops.cc:79] argmax(out) = [3 6 9 8 3 9 1 0 1 1 9 3 2 3
[2016-06-03 00:11:08.661563] Epoch 00, Loss = 0.332199
```

缺点:函数过于简单,没法在满足一定条件下进行输出,或者隔多少次迭代才进行一次输出.

```
tf.Assert(condition, data, summarize=None, name=None)
```

这个函数在condition等于False的时候进行输出data的值,并且抛出异常,summarize决定输出多少变量值

使用方法:

```
def multilayer_perceptron(x):
    fc1 = layers.fully_connected(x, 256, activation_fn=tf.nn.relu, scope='fc1'
    fc2 = layers.fully_connected(fc1, 256, activation_fn=tf.nn.relu, scope='fc
    out = layers.fully_connected(fc2, 10, activation_fn=None, scope='out')
    # let's ensure that all the outputs in `out` are positive
    assert_op = tf.Assert(tf.reduce_all(out > 0), [out], name='assert_out_posi
    with tf.control_dependencies([assert_op]):
        out = tf.identity(out, name='out')
    return out
```

或者可以:

```
    # ... same as above ...
    out = tf.with_dependencies([assert_op], out)
    return out
```

或者把所有的Assert操作加入collection:

```
def multilayer_perceptron(x):
    fc1 = layers.fully_connected(x, 256, activation_fn=tf.nn.relu, scope='fc1'
    fc2 = layers.fully_connected(fc1, 256, activation_fn=tf.nn.relu, scope='fc
    out = layers.fully_connected(fc2, 10, activation_fn=None, scope='out')
    tf.add_to_collection('Asserts',
        tf.Assert(tf.reduce_all(out > 0), [out], name='assert_out_gt_0')
    )
    return out

# merge all assertion ops from the collection
assert_op = tf.group(*tf.get_collection('Asserts'))
```

```
... = session.run([train_op, assert_op], feed_dict={...})
```

官方也提供了一些assert相关的函数: https://www.tensorflow.org/versions/r0.12/api_docs/python/check_ops.html#asserts-and-boolean-checks

```
tf.assert_negative(x, data=None, summarize=None, name=None)
tf.assert_positive(x, data=None, summarize=None, name=None)
tf.assert_proper_iterable(values)
tf.assert_non_negative(x, data=None, summarize=None, name=None)
tf.assert_non_positive(x, data=None, summarize=None, name=None)
tf.assert_equal(x, y, data=None, summarize=None, name=None)
tf.assert_integer(x, data=None, summarize=None, name=None)
tf.assert_less(x, y, data=None, summarize=None, name=None)
tf.assert_less_equal(x, y, data=None, summarize=None, name=None)
tf.assert_rank(x, rank, data=None, summarize=None, name=None)
tf.assert_rank_at_least(x, rank, data=None, summarize=None, name=None)
tf.assert_type(tensor, tf_type)
tf.is_non_decreasing(x, name=None)
tf.is_numeric_tensor(tensor)
tf.is_strictly_increasing(x, name=None)
```

4.使用Python的debug工具: ipdb, pudb

5.利用tf.py_func()向图中插入自定义的打印代码

```
tf.py_func(func, inp, Tout, stateful=True, name=None)
```

简单例子:

```
def my_func(x):
    # x will be a numpy array with the contents of the placeholder below
    return np.sinh(x)

inp = tf.placeholder(tf.float32, [...])
y = py_func(my_func, [inp], [tf.float32])
```

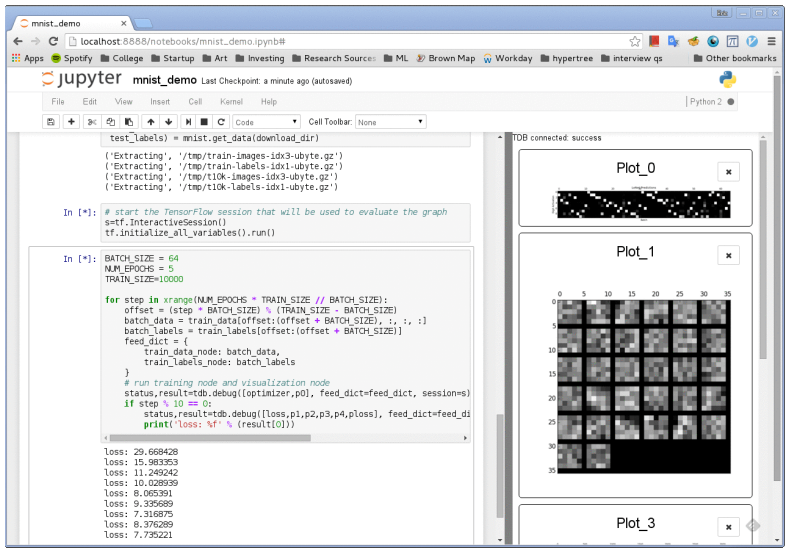
另一个例子:

```
def multilayer_perceptron(x):
    fc1 = layers.fully_connected(x, 256, activation_fn=tf.nn.relu, scope='fc1')
    fc2 = layers.fully_connected(fc1, 256, activation_fn=tf.nn.relu, scope='fc2')
    out = layers.fully_connected(fc2, 10, activation_fn=None, scope='out')

    def _debug_print_func(fc1_val, fc2_val):
        print 'FC1 : {}, FC2 : {}'.format(fc1_val.shape, fc2_val.shape)
        print 'min, max of FC2 = {}, {}'.format(fc2_val.min(), fc2_val.max())
        return False

    debug_print_op = tf.py_func(_debug_print_func, [fc1, fc2], [tf.bool])
    with tf.control_dependencies(debug_print_op):
        out = tf.identity(out, name='out')
    return out
```

一个第三方debug工具: https://github.com/ericjang/tdb



6.使用官方debug工具: tfdbg

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