Quick Tensorflow Tutorial

Andreas Eitel

AIS Autonomous Intelligent Systems

First Organization

- Computers in Pool are equipped with Nvidia GPUs GTX 1060 to train your networks
- Tensorflow 1.1 is already installed
- We'll meet from now one in the computer pool every Monday to help you with the exercises

What is a Tensor?

- Central unit of data in TensorFlow
- A tensor consists of a set of primitive values shaped into an array
- A scalar is a Tensor
- A vector is a Tensor
- A matrix is a Tensor

```
3 # a rank 0 tensor; a scalar with shape []
[1., 2., 3.] # a rank 1 tensor; a vector with shape [3]
[[1., 2., 3.], [4., 5., 6.]] # a rank 2 tensor; a matrix with shape [2, 3]
[[[1., 2., 3.]], [[7., 8., 9.]]] # a rank 3 tensor with shape [2, 1, 3]
```

Tensorflow vs. Numpy

- Both support Ndarrays
- Both use python as front-end
- Numpy does not offer methods to create tensors
- Numpy has no automatic derivative computation
- Numpy has no GPU support

Tensorflow vs. Numpy

In [38]:
```
1 import numpy as np
```

In [51]:
```
1  a = np.zeros((2,2)); b = np.ones((2,2))
```

In [52]:
```
1  np.sum(b, axis=1)
```

Out[52]:
```
array([ 2.,  2.])
```

In [53]:
```
1 a.shape
```

Out[53]:
```
(2, 2)
```

In [54]:
```
1 np.reshape(a, (1,4))
```

Out[54]:
```
array([[ 0.,  0.,  0.,  0.]])
```

In [55]:
```
1 np.dot(a,b)
```

Out[55]:
```
array([[ 0.,  0.],
       [ 0.,  0.]])
```

Tensorflow vs. Numpy

In [38]:
```
import numpy as np
```

In [51]:
```
 a = np.zeros((2,2)); b = np.ones((2,2))
```

In [52]:
```
 np.sum(b, axis=1)
```

Out[52]:
```
array([ 2.,  2.])
```

In [53]:
```
a.shape
```

Out[53]:
```
(2, 2)
```

In [54]:
```
np.reshape(a, (1,4))
```

Out[54]:
```
array([[ 0.,  0.,  0.,  0.]])
```

In [55]:
```
np.dot(a,b)
```

Out[55]:
```
array([[ 0.,  0.],
       [ 0.,  0.]])
```

In [56]:
```
import tensorflow as tf
```

In [57]:
```
tf.InteractiveSession()
a = tf.zeros((2,2)); b = tf.ones((2,2))
```

In [58]:
```
a.get_shape()

```

Out[58]:
```
TensorShape([Dimension(2), Dimension(2)])
```

In [59]:
```
tf.reshape(a, (1,4)).eval()
```

Out[59]:
```
array([[ 0.,  0.,  0.,  0.]], dtype=float32)
```

Requires explicit evaluation

In [61]:
```
tf.matmul(a,b).eval()
```

Out[61]:
```
array([[ 0.,  0.],
       [ 0.,  0.]], dtype=float32)
```

Tensorflow Sessions

- A computional graph is a series of Tensorflow operations arranged into a graph of nodes
- To evaluate nodes, we must run a **session**

In [65]:

```
with tf.Session() as sess:
    print(sess.run(tf.matmul(a,b)))
    print("is the same as")
    print(tf.matmul(a,b).eval())
```

```
[[ 0.  0.]
 [ 0.  0.]]
is the same as
[[ 0.  0.]
 [ 0.  0.]]
```

Placeholders and Variables

- For machine learning you want a model to take arbitrary inputs and add trainable parameters to the graph
- External input using **Placeholders**
- Trainable parameters using **Variables**, which are constructed with type and initial value

In [66]:
```
1 x = tf.placeholder(tf.float32)
2 W = tf.Variable([.3], dtype=tf.float32)
3 b = tf.Variable([-.3], dtype=tf.float32)
```

In [67]:
```
1 linear_model = W*x + b
```

Initialization

- Variables are not initialized when calling tf.Variable
- Need to call initialization

In [66]:
```
x = tf.placeholder(tf.float32)
W = tf.Variable([.3], dtype=tf.float32)
b = tf.Variable([-.3], dtype=tf.float32)
```

In [73]:
```
linear_model = W*x + b
```

In [79]:
```
with tf.Session() as sess:
    sess.run(tf.global_variables_initializer())
    print(sess.run(W))
    print(sess.run(b))
```

```
[ 0.30000001]
[-0.30000001]
```

Evaluation

Use the Placeholder to evaluate linear_model for several values of x

In [66]:
```
x = tf.placeholder(tf.float32)
W = tf.Variable([.3], dtype=tf.float32)
b = tf.Variable([-.3], dtype=tf.float32)
```

In [73]:
```
linear_model = W*x + b
```

In [81]:
```
with tf.Session() as sess:
    sess.run(tf.global_variables_initializer())
    print(sess.run(linear_model, {x: [1, 2, 3, 4]}))
```

```
[ 0.          0.30000001  0.60000002  0.90000004]
```

Linear Regression Example

Still need labels, loss and optimizer for optimizing the paramters W,b

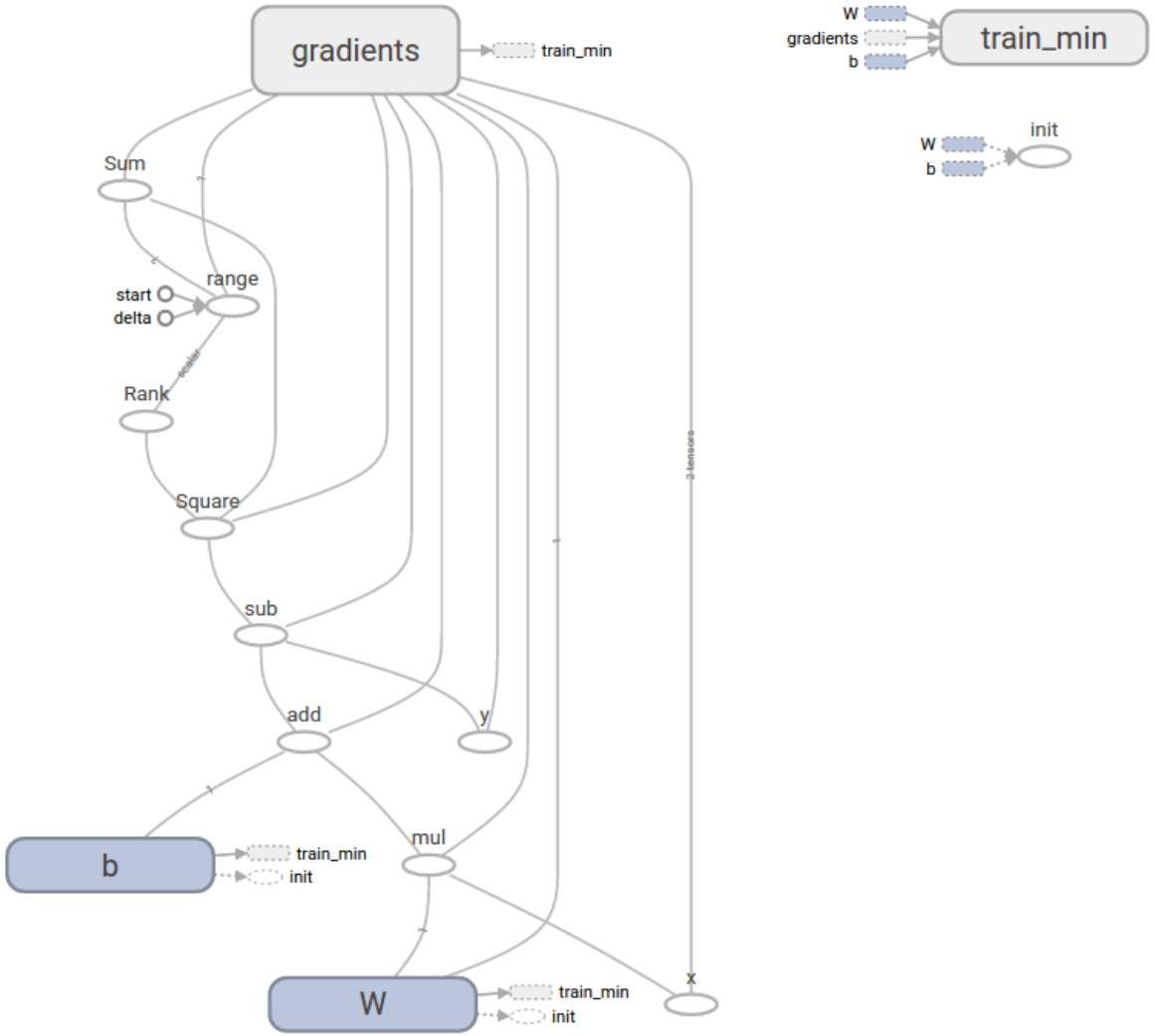
In [66]:
```
x = tf.placeholder(tf.float32)
W = tf.Variable([.3], dtype=tf.float32)
b = tf.Variable([-.3], dtype=tf.float32)
```

In [73]:
```
linear_model = W*x + b
```

In [83]:
```
# labels
y = tf.placeholder(tf.float32)

# loss
loss = tf.reduce_sum(tf.square(linear_model - y)) # sum of the squares
# optimizer
optimizer = tf.train.GradientDescentOptimizer(0.01)
train = optimizer.minimize(loss)

# training data
x_train = [1, 2, 3, 4]
y_train = [0, -1, -2, -3]
# training loop
init = tf.global_variables_initializer()
sess = tf.Session()
sess.run(init) # reset values to wrong
for i in range(1000):
  sess.run(train, {x: x_train, y: y_train})

# evaluate training accuracy
curr_W, curr_b, curr_loss = sess.run([W, b, loss], {x: x_train, y: y_train})
print("W: %s b: %s loss: %s"%(curr_W, curr_b, curr_loss))
```

```
W: [-0.9999969] b: [ 0.99999082] loss: 5.69997e-11
```

Visualize the Graph in TensorBoard



Thank you for your attention!