

With TF 1.0!



# Lab 2

## Linear Regression

Sung Kim <[hunkim+ml@gmail.com](mailto:hunkim+ml@gmail.com)>

Code: <https://github.com/hunkim/DeepLearningZeroToAll/>



# Call for comments

Please feel free to add comments directly on these slides

Other slides: <https://goo.gl/jPtVNT>



With TF 1.0!



# Lab 2

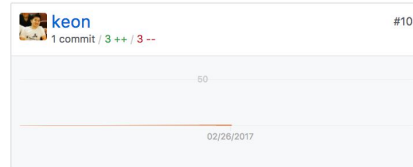
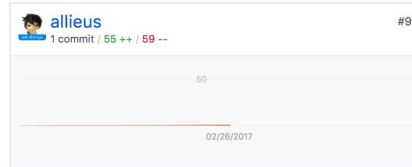
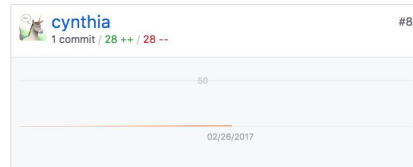
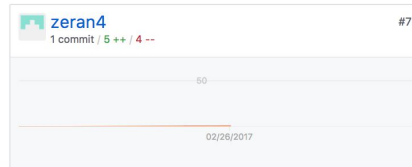
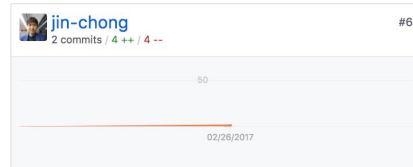
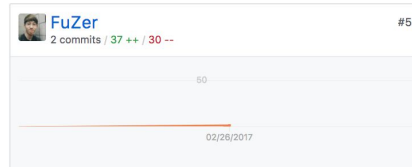
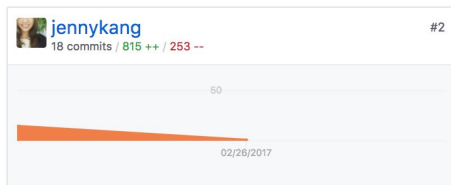
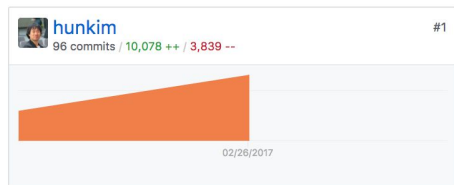
## Linear Regression

Sung Kim <[hunkim+ml@gmail.com](mailto:hunkim+ml@gmail.com)>

Code: <https://github.com/hunkim/DeepLearningZeroToAll/>



<https://github.com/hunkim/DeepLearningZeroToAll/>



# Hypothesis and cost function

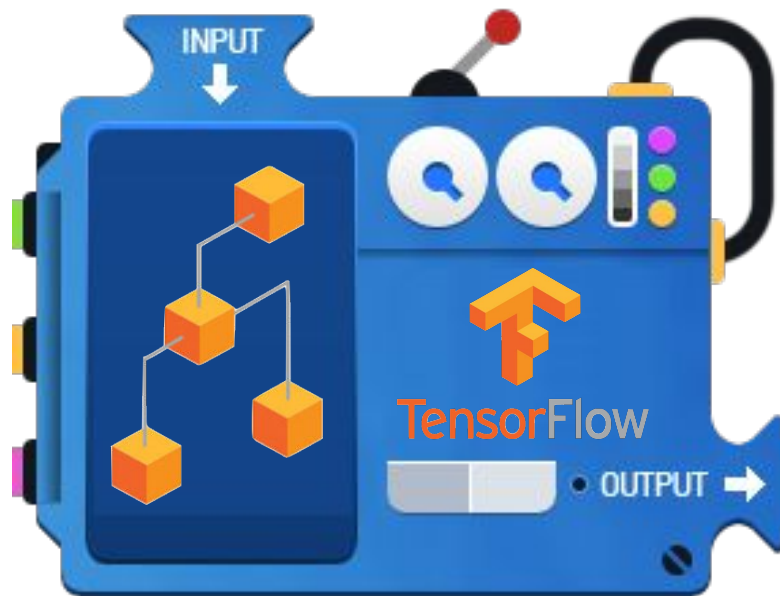
$$H(x) = Wx + b$$

$$cost(W, b) = \frac{1}{m} \sum_{i=1}^m (H(x^{(i)}) - y^{(i)})^2$$

# TensorFlow Mechanics

2 feed data and run graph (operation)  
***sess.run (op, feed\_dict={x: x\_data})***

1 Build graph using  
TensorFlow operations



3 update variables  
in the graph  
(and return values)

1

## Build graph using TF operations

$$H(x) = Wx + b$$

```
# X and Y data
x_train = [1, 2, 3]
y_train = [1, 2, 3]

W = tf.Variable(tf.random_normal([1]), name='weight')
b = tf.Variable(tf.random_normal([1]), name='bias')
# Our hypothesis XW+b
hypothesis = x_train * W + b
```

$$cost(W, b) = \frac{1}{m} \sum_{i=1}^m (H(x^{(i)}) - y^{(i)})^2$$

```
# cost/loss function
cost = tf.reduce_mean(tf.square(hypothesis - y_train))
```

1

## Build graph using TF operations

$$\text{cost}(W, b) = \frac{1}{m} \sum_{i=1}^m (H(x^{(i)}) - y^{(i)})^2$$

```
t = [1., 2., 3., 4.]  
tf.reduce_mean(t) ==> 2.5
```

```
# cost/loss function  
cost = tf.reduce_mean(tf.square(hypothesis - y_train))
```

## GradientDescent

```
# Minimize  
optimizer = tf.train.GradientDescentOptimizer(learning_rate=0.01)  
train = optimizer.minimize(cost)
```



2  
3

## Run/update graph and get results

*# Launch the graph in a session.*

```
sess = tf.Session()
```

*# Initializes global variables in the graph.*

```
sess.run(tf.global_variables_initializer())
```

*# Fit the line*

```
for step in range(2001):
```

```
    sess.run(train)
```

```
    if step % 20 == 0:
```

```
        print(step, sess.run(cost), sess.run(W), sess.run(b))
```

# Full code (less than 20 lines)

```
import tensorflow as tf

# X and Y data
x_train = [1, 2, 3]
y_train = [1, 2, 3]

W = tf.Variable(tf.random_normal([1]), name='weight')
b = tf.Variable(tf.random_normal([1]), name='bias')

# Our hypothesis XW+b
hypothesis = x_train * W + b

# cost/loss function
cost = tf.reduce_mean(tf.square(hypothesis - y_train))

# Minimize
optimizer = tf.train.GradientDescentOptimizer(learning_rate=0.01)
train = optimizer.minimize(cost)

# Launch the graph in a session.
sess = tf.Session()

# Initializes global variables in the graph.
sess.run(tf.global_variables_initializer())

# Fit the line
for step in range(2001):
    sess.run(train)
    if step % 20 == 0:
        print(step, sess.run(cost), sess.run(W), sess.run(b))
```

```
...
0 2.82329 [ 2.12867713] [-0.85235667]
20 0.190351 [ 1.53392804] [-1.05059612]
40 0.151357 [ 1.45725465] [-1.02391243]
...

1920 1.77484e-05 [ 1.00489295] [-0.01112291]
1940 1.61197e-05 [ 1.00466311] [-0.01060018]
1960 1.46397e-05 [ 1.004444] [-0.01010205]
1980 1.32962e-05 [ 1.00423515] [-0.00962736]
2000 1.20761e-05 [ 1.00403607] [-0.00917497]
...
```

# Placeholders

```
In [7]: a = tf.placeholder(tf.float32)
b = tf.placeholder(tf.float32)
adder_node = a + b # + provides a shortcut for tf.add(a, b)

print(sess.run(adder_node, feed_dict={a: 3, b: 4.5}))
print(sess.run(adder_node, feed_dict={a: [1,3], b: [2, 4]}))
```

7.5

[ 3. 7.]

# Placeholders

*# X and Y data*

```
x_train = [1, 2, 3]
```

```
y_train = [1, 2, 3]
```

*# Now we can use X and Y in place of x\_data and y\_data*

*# # placeholders for a tensor that will be always fed using feed\_dict*

*# See <http://stackoverflow.com/questions/36693740/>*

```
X = tf.placeholder(tf.float32)
```

```
Y = tf.placeholder(tf.float32)
```

```
...
```

*# Fit the line*

*# Fit the line*

```
for step in range(2001):
```

```
    cost_val, W_val, b_val, _ = \
```

```
        sess.run([cost, W, b, train],
```

```
                feed_dict={X: [1, 2, 3], Y: [1, 2, 3]}))
```

```
if step % 20 == 0:
```

```
    print(step, cost_val, W_val, b_val)
```

# Full code with placeholders

```
import tensorflow as tf

W = tf.Variable(tf.random_normal([1]), name='weight')
b = tf.Variable(tf.random_normal([1]), name='bias')

X = tf.placeholder(tf.float32, shape=[None])
Y = tf.placeholder(tf.float32, shape=[None])

# Our hypothesis XW+b
hypothesis = X * W + b

# cost/loss function
cost = tf.reduce_mean(tf.square(hypothesis - Y))

# Minimize
optimizer = tf.train.GradientDescentOptimizer(learning_rate=0.01)
train = optimizer.minimize(cost)

# Launch the graph in a session.
sess = tf.Session()

# Initializes global variables in the graph.
sess.run(tf.global_variables_initializer())

# Fit the line
for step in range(2001):
    cost_val, W_val, b_val, _ = sess.run([cost, W, b, train],
                                          feed_dict={X: [1, 2, 3], Y: [1, 2, 3]})
    if step % 20 == 0:
        print(step, cost_val, W_val, b_val)
```

```
...
1980 1.32962e-05 [ 1.00423515] [-0.00962736]
2000 1.20761e-05 [ 1.00403607] [-0.00917497]

# Testing our model
print(sess.run(hypothesis, feed_dict={X: [5]}))
print(sess.run(hypothesis, feed_dict={X: [2.5]}))
print(sess.run(hypothesis,
               feed_dict={X: [1.5, 3.5]}))

[ 5.0110054]
[ 2.50091505]
[ 1.49687922 3.50495124]
```

# Full code with placeholders

```
import tensorflow as tf

W = tf.Variable(tf.random_normal([1]), name='weight')
b = tf.Variable(tf.random_normal([1]), name='bias')
X = tf.placeholder(tf.float32, shape=[None])
Y = tf.placeholder(tf.float32, shape=[None])

# Our hypothesis XW+b
hypothesis = X * W + b
# cost/loss function
cost = tf.reduce_mean(tf.square(hypothesis - Y))
# Minimize
optimizer = tf.train.GradientDescentOptimizer(learning_rate=0.01)
train = optimizer.minimize(cost)

# Launch the graph in a session.
sess = tf.Session()
# Initializes global variables in the graph.
sess.run(tf.global_variables_initializer())

# Fit the line with new training data
for step in range(2001):
    cost_val, W_val, b_val, _ = sess.run([cost, W, b, train],
        feed_dict={X: [1, 2, 3, 4, 5],
                    Y: [2.1, 3.1, 4.1, 5.1, 6.1]})
    if step % 20 == 0:
        print(step, cost_val, W_val, b_val)
```

```
...
1960 3.32396e-07 [ 1.00037301] [ 1.09865296]
1980 2.90429e-07 [ 1.00034881] [ 1.09874094]
2000 2.5373e-07 [ 1.00032604] [ 1.09882331]

# Testing our model
print(sess.run(hypothesis, feed_dict={X: [5]}))
print(sess.run(hypothesis, feed_dict={X: [2.5]}))
print(sess.run(hypothesis,
                feed_dict={X: [1.5, 3.5]}))

[ 6.10045338]
[ 3.59963846]
[ 2.59931231  4.59996414]
```

# TensorFlow Mechanics

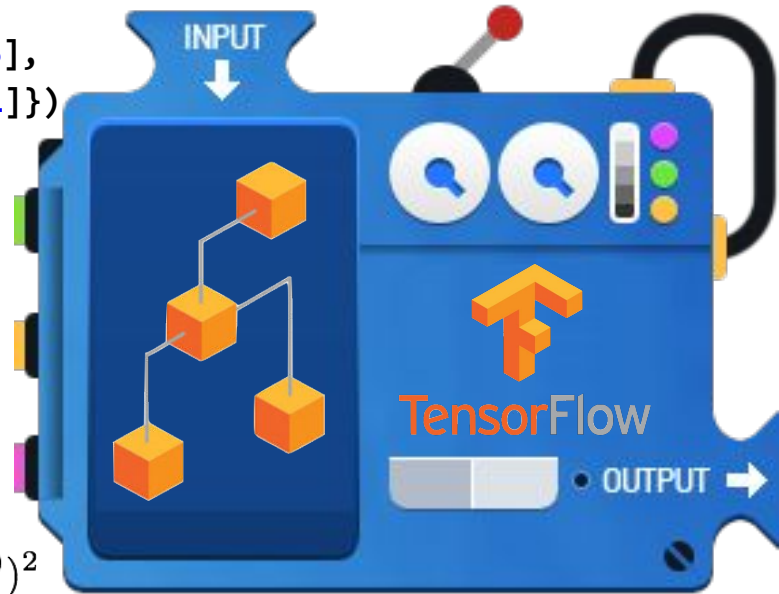
2 feed data and run graph (operation)  
**`sess.run (op, feed_dict={x: x_data})`**

`feed_dict={X: [1, 2, 3, 4, 5],  
Y: [2.1, 3.1, 4.1, 5.1, 6.1]}`

1 Build graph using  
TensorFlow operations

$$H(x) = Wx + b$$

$$\text{cost}(W, b) = \frac{1}{m} \sum_{i=1}^m (H(x^{(i)}) - y^{(i)})^2$$



3 update variables  
in the graph  
(and return values)

With TF 1.0!



# Lab 3

## Minimizing Cost

Sung Kim <hunkim+ml@gmail.com>