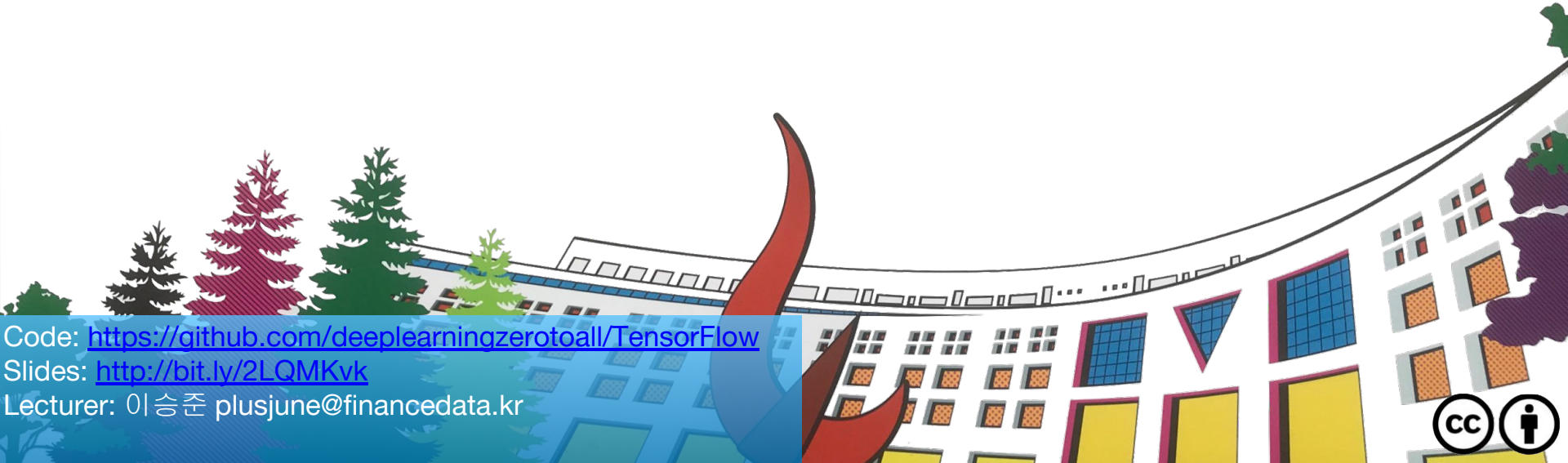
ML/DL for Everyone Season2

with TensorFlow

04 - Multi-variable linear regression LAB



Code: https://github.com/deeplearningzerotoall/TensorFlow
Slides: http://bit.ly/2LQMKvk
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Hypothesis using matrix

$$H(x_1, x_2, x_3) = w_1 x_1 + w_2 x_2 + w_3 x_3$$

x_1	x_2	x_3	y
73	80	75	152
93	88	93	185
89	91	90	180
96	98	100	196
73	66	70	142

Test Scores for General Psychology

https://www.symbolab.com/solver/matrix-calculator

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73	80	75	152
93	88	93	185
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96	98	100	196
73	66	70	142

Test Scores for General Psychology

```
# data and label
x1 = [ 73.,  93.,  89.,  96.,  73.]
x2 = [ 80.,  88.,  91.,  98.,  66.]
x3 = [ 75.,  93.,  90., 100.,  70.]
Y  = [152., 185., 180., 196., 142.]

# weights
w1 = tf.Variable(10.)
w2 = tf.Variable(10.)
w3 = tf.Variable(10.)
b  = tf.Variable(10.)

hypothesis = w1 * x1 +  w2 * x2 + w3 * x3 + b
```

https://www.symbolab.com/solver/matrix-calculator

```python
# data and label
x1 = [ 73.,  93.,  89.,  96.,  73.]
x2 = [ 80.,  88.,  91.,  98.,  66.]
x3 = [ 75.,  93.,  90., 100.,  70.]
Y  = [152., 185., 180., 196., 142.]

# random weights
w1 = tf.Variable(tf.random_normal([1]))
w2 = tf.Variable(tf.random_normal([1]))
w3 = tf.Variable(tf.random_normal([1]))
b  = tf.Variable(tf.random_normal([1]))

learning_rate = 0.000001

for i in range(1000+1):
    # tf.GradientTape() to record the gradient of the cost function
    with tf.GradientTape() as tape:
        hypothesis = w1 * x1 +  w2 * x2 + w3 * x3 + b
        cost = tf.reduce_mean(tf.square(hypothesis - Y))
    # calculates the gradients of the cost
    w1_grad, w2_grad, w3_grad, b_grad = tape.gradient(cost, [w1, w2, w3, b])

    # update w1,w2,w3 and b
    w1.assign_sub(learning_rate * w1_grad)
    w2.assign_sub(learning_rate * w2_grad)
    w3.assign_sub(learning_rate * w3_grad)
    b.assign_sub(learning_rate * b_grad)

    if i % 50 == 0:
      print("{:5} | {:12.4f}".format(i, cost.numpy()))
```

```
    0 |   11325.9121
   50 |     135.3618
  100 |      11.1817
  150 |       9.7940
  200 |       9.7687
  250 |       9.7587
  300 |       9.7489
  350 |       9.7389
  400 |       9.7292
  450 |       9.7194
  500 |       9.7096
  550 |       9.6999
  600 |       9.6903
  650 |       9.6806
  700 |       9.6709
  750 |       9.6612
  800 |       9.6517
  850 |       9.6421
  900 |       9.6325
  950 |       9.6229
 1000 |       9.6134
```

Matrix

```
data = np.array([
    # X1,   X2,    X3,   y
    [ 73.,  80.,  75., 152. ],
    [ 93.,  88.,  93., 185. ],
    [ 89.,  91.,  90., 180. ],
    [ 96.,  98., 100., 196. ],
    [ 73.,  66.,  70., 142. ]
], dtype=np.float32)

# slice data
X = data[:, :-1]
y = data[:, [-1]]
```

$$H(X) = XW$$

```
W = tf.Variable(tf.random_normal([3, 1]))
b = tf.Variable(tf.random_normal([1]))

# hypothesis, prediction function
def predict(X):
  return tf.matmul(X, W) + b
```

```
data = np.array([
    # X1,   X2,    X3,   y
    [ 73.,  80.,  75., 152. ],
    [ 93.,  88.,  93., 185. ],
    [ 89.,  91.,  90., 180. ],
    [ 96.,  98., 100., 196. ],
    [ 73.,  66.,  70., 142. ]
], dtype=np.float32)
```

```
# slice data
X = data[:, :-1]
y = data[:, [-1]]

W = tf.Variable(tf.random_normal([3, 1]))
b = tf.Variable(tf.random_normal([1]))

learning_rate = 0.000001

# hypothesis, prediction function
def predict(X):
  return tf.matmul(X, W) + b

n_epochs = 2000
for i in range(n_epochs+1):
    # record the gradient of the cost function
    with tf.GradientTape() as tape:
        cost = tf.reduce_mean((tf.square(predict(X) - y)))

    # calculates the gradients of the loss
    W_grad, b_grad = tape.gradient(cost, [W, b])

    # updates parameters (W and b)
    W.assign_sub(learning_rate * W_grad)
    b.assign_sub(learning_rate * b_grad)

    if i % 100 == 0:
      print("{:5} | {:10.4f}".format(i, cost.numpy()))
```

```
epoch | cost
    0 | 112662.8359
  100 |    17.9033
  200 |     4.0140
  300 |     3.9923
  400 |     3.9724
  500 |     3.9527
  600 |     3.9330
  700 |     3.9134
  800 |     3.8939
  900 |     3.8746
 1000 |     3.8553
 1100 |     3.8362
 1200 |     3.8171
 1300 |     3.7981
 1400 |     3.7793
 1500 |     3.7606
 1600 |     3.7419
 1700 |     3.7234
 1800 |     3.7049
 1900 |     3.6866
 2000 |     3.6684
```

With Matrix

$$\begin{pmatrix} x_1 & x_2 & x_3 \end{pmatrix} \cdot \begin{pmatrix} w_1 \\ w_2 \\ w_3 \end{pmatrix} = \begin{pmatrix} x_1 w_1 + x_2 w_2 + x_3 w_3 \end{pmatrix}$$

$$H(X) = XW$$

```
# initialize W
w1 = tf.Variable(tf.random_normal([1]))
w2 = tf.Variable(tf.random_normal([1]))
w3 = tf.Variable(tf.random_normal([1]))

# hypothesis, prediction function
w1 * x1 +  w2 * x2 + w3 * x3 + b

# update w1,w2,w3
w1.assign_sub(learning_rate * w1_grad)
w2.assign_sub(learning_rate * w2_grad)
w3.assign_sub(learning_rate * w3_grad)
```

```
# initialize W
W = tf.Variable(tf.random_normal([3, 1]))

# hypothesis, prediction function
tf.matmul(X, W) + b

# updates parameters (W and b)
W.assign_sub(learning_rate * W_grad)
```

What’s Next?

- Logistic (Regression) Classification