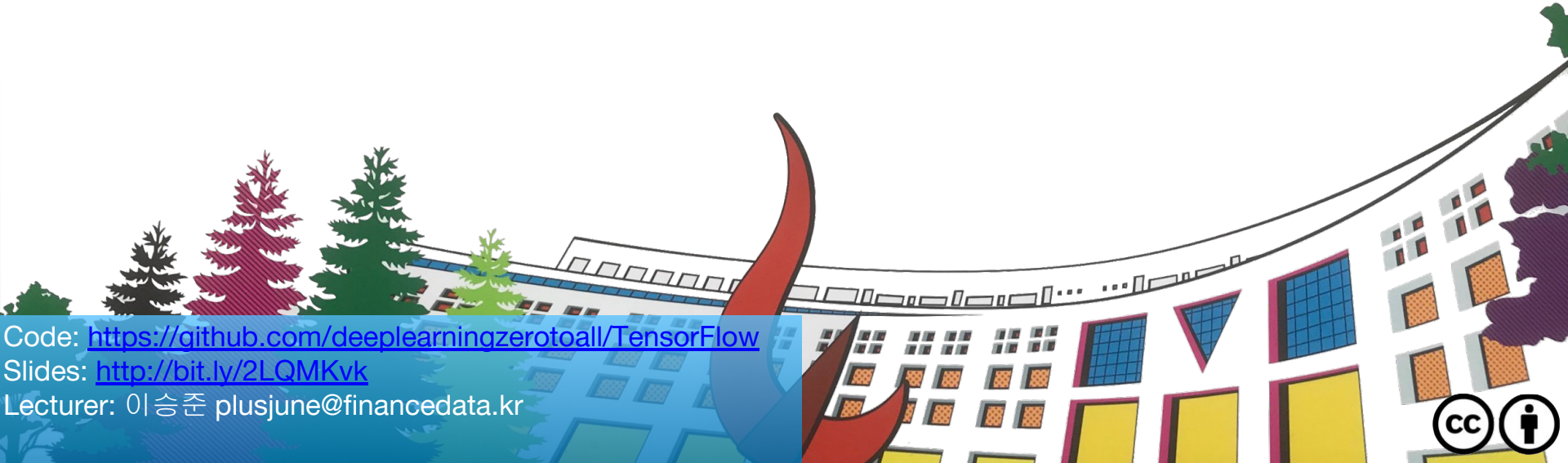
# ML/DL for Everyone Season2

with TensorFlow

## 03 - How to minimize cost LAB



Code: https://github.com/deeplearningzerotoall/TensorFlow
Slides: http://bit.ly/2LQMKvk
Lecturer: 이승준 plusjune@financedata.kr

# Simplified hypothesis

Hypothesis $$H(x) = Wx$$

Cost $$cost(W) = \frac{1}{m} \sum_{i=1}^{m} (Wx_i - y_i)^2$$

# Cost function in pure Python

$$cost(W) = \frac{1}{m} \sum_{i=1}^{m} (Wx_i - y_i)^2$$

```
import numpy as np

X = np.array([1, 2, 3])
Y = np.array([1, 2, 3])

def cost_func(W, X, Y):
    c = 0
    for i in range(len(X)):
        c += (W * X[i] - Y[i]) ** 2
    return c / len(X)

for feed_W in np.linspace(-3, 5, num=15):
    curr_cost = cost_func(feed_W, X, Y)
    print("{:6.3f} | {:10.5f}".format(feed_W, curr_cost))
```

```
    W          cost
-3.000 |   74.66667
-2.429 |   54.85714
-1.857 |   38.09524
-1.286 |   24.38095
-0.714 |   13.71429
-0.143 |    6.09524
 0.429 |    1.52381
 1.000 |    0.00000
 1.571 |    1.52381
 2.143 |    6.09524
 2.714 |   13.71429
 3.286 |   24.38095
 3.857 |   38.09524
 4.429 |   54.85714
 5.000 |   74.66667
```

# Cost function in pure Python

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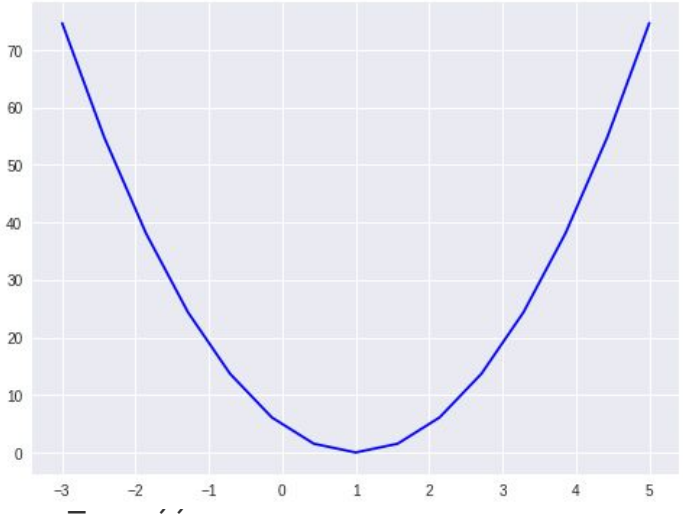
```



# Cost function in TensorFlow

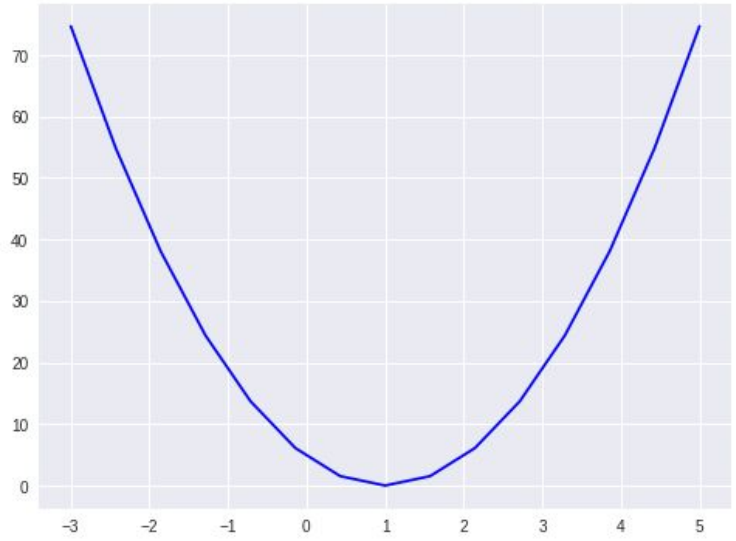
$$cost(W) = \frac{1}{m}\sum_{i=1}^{m}(Wx_i - y_i)^2$$

```
X = np.array([1, 2, 3])
Y = np.array([1, 2, 3])

def cost_func(W, X, Y):
  hypothesis = X * W
  return tf.reduce_mean(tf.square(hypothesis - Y))

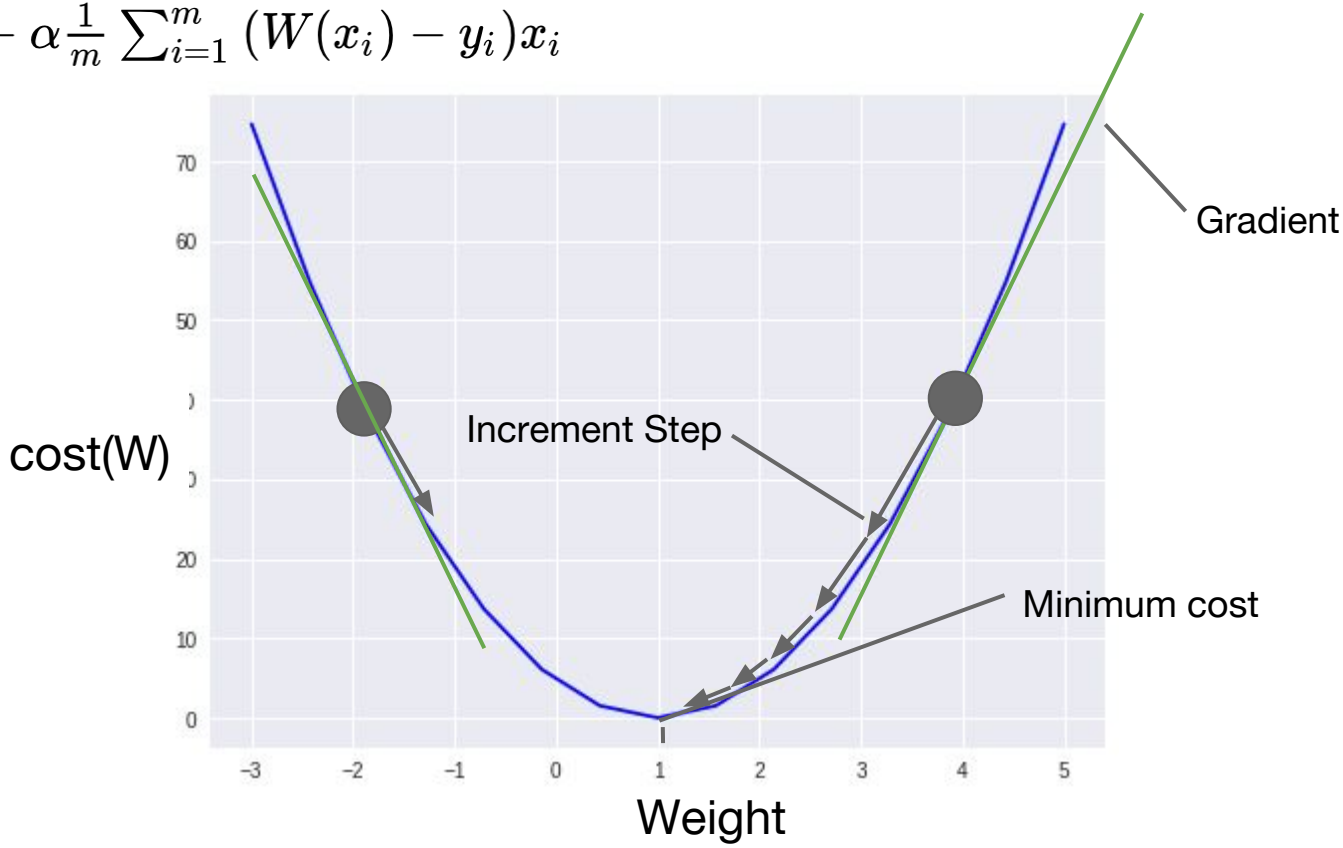
W_values = np.linspace(-3, 5, num=15)
cost_values = []

for feed_W in W_values:
    curr_cost = cost_func(feed_W, X, Y)
    cost_values.append(curr_cost)
    print("{:6.3f} | {:10.5f}".format(feed_W, curr_
```



# Gradient descent

$$W := W - \alpha \frac{1}{m} \sum_{i=1}^{m} (W(x_i) - y_i) x_i$$



# Gradient descent

$$cost(W) = \frac{1}{m}\sum_{i=1}^{m}(Wx_i - y_i)^2$$

$$W := W - \alpha\frac{1}{m}\sum_{i=1}^{m}(W(x_i) - y_i)x_i$$

```
alpha = 0.01
gradient = tf.reduce_mean(tf.multiply(tf.multiply(W, X) - Y, X))
descent = W - tf.multiply(alpha, gradient)
W.assign(descent)
```

# Gradient descent

```
tf.set_random_seed(0)  # for reproducibility

x_data = [1., 2., 3., 4.]
y_data = [1., 3., 5., 7.]

W = tf.Variable(tf.random_normal([1], -100., 100.))

for step in range(300):
    hypothesis = W * X
    cost = tf.reduce_mean(tf.square(hypothesis - Y))

    alpha = 0.01
    gradient = tf.reduce_mean(tf.multiply(tf.multiply(W, X) - Y, X))
    descent = W - tf.multiply(alpha, gradient)
    W.assign(descent)

    if step % 10 == 0:
        print('{:5} | {:10.4f} | {:10.6f}'.format(
            step, cost.numpy(), W.numpy()[0]))
```

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# Gradient descent

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        print('{:5} | {:10.4f} | {:10.6f}'.format(
            step, cost.numpy(), W.numpy()[0]))
```
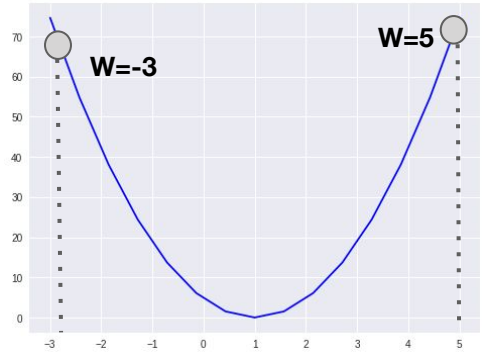

```
step        cost             W

  0 | 11716.3086 |   48.767971
 10 |  4504.9126 |   30.619968
 20 |  1732.1364 |   19.366755
 30 |   666.0052 |   12.388859
 40 |   256.0785 |    8.062004
 50 |    98.4620 |    5.379007
 60 |    37.8586 |    3.715335
 70 |    14.5566 |    2.683725
 80 |     5.5970 |    2.044044
 ......
240 |     0.0000 |    1.000499
250 |     0.0000 |    1.000309
260 |     0.0000 |    1.000192
270 |     0.0000 |    1.000119
280 |     0.0000 |    1.000074
290 |     0.0000 |    1.000046
```

# Output when W=5




```python
tf.set_random_seed(0)  # for reproducibility

x_data = [1., 2., 3., 4.]
y_data = [1., 3., 5., 7.]

W = tf.Variable([5.0])

for step in range(300):
    hypothesis = W * X
    cost = tf.reduce_mean(tf.square(hypothesis - Y))

    alpha = 0.01
    gradient = tf.reduce_mean(tf.multiply(tf.multiply(W, X) - Y, X)
    descent = W - tf.multiply(alpha, gradient)
    W.assign(descent)

    if step % 10 == 0:
        print('{:5} | {:10.4f} | {:10.6f}'.format(
            step, cost.numpy(), W.numpy()[0]))
```

| step | cost | W |
|---|---|---|
| 0 | 74.6667 | 4.813334 |
| 10 | 28.7093 | 3.364572 |
| 20 | 11.0387 | 2.466224 |
| 30 | 4.2444 | 1.909177 |
| 40 | 1.6320 | 1.563762 |
| 50 | 0.6275 | 1.349578 |
| 60 | 0.2413 | 1.216766 |
| 70 | 0.0928 | 1.134412 |
| 80 | 0.0357 | 1.083346 |
| .... | .... | |
| 270 | 0.0000 | 1.000009 |
| 280 | 0.0000 | 1.000006 |
| 290 | 0.0000 | 1.000004 |

# What’s Next?

- Multi-Variable Linear regression