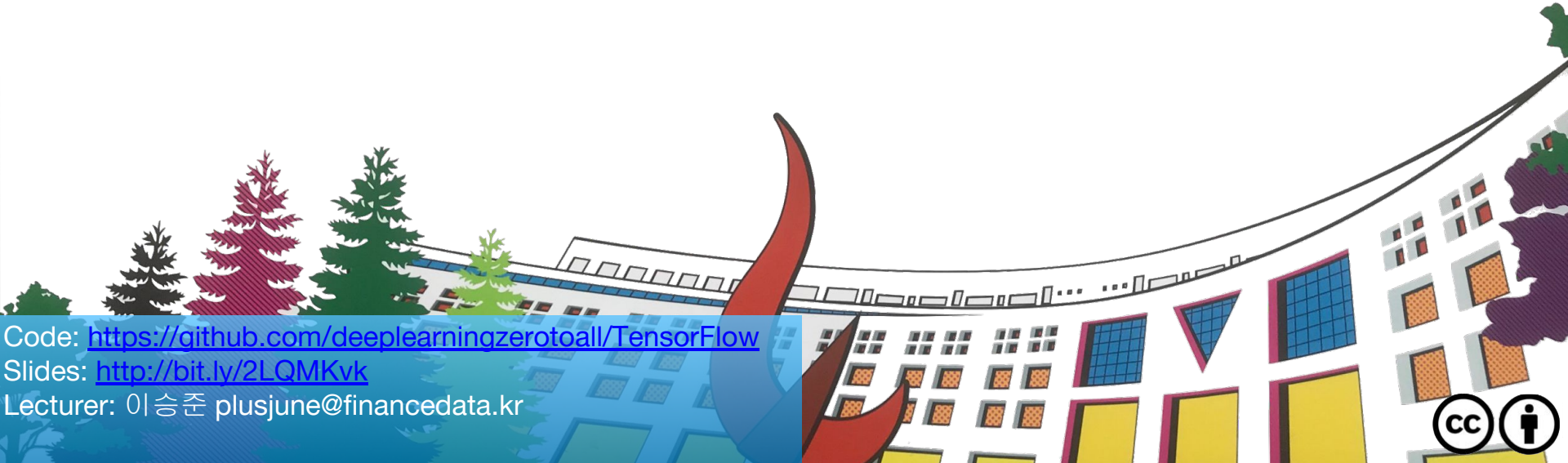
ML/DL for Everyone Season2

with TensorFlow

03 - How to minimize cost



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

Hypothesis and Cost

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

행렬식으로 포함시킴

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

에러

분산을 최소화하는 것

Simplified hypothesis

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

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

What cost(W) looks like?

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

- W = 0, cost(W) = ?

x	y
1	1
2	2
3	3

What cost(W) looks like?

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

x	y
1	1
2	2
3	3

- W = 0, cost(W) = 4.67

  $\frac{1}{3}((0 * 1 - 1)^2 + (0 * 2 - 2)^2 + (0 * 3 - 3)^2))$

What cost(W) looks like?

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

x	y
1	1
2	2
3	3

- W = 0, cost(W) = 4.67

  $\frac{1}{3}((0*1-1)^2 + (0*2-2)^2 + (0*3-3)^2))$

- W = 1, cost(W) = 0

  $\frac{1}{3}((1*1-1)^2 + (1*2-2)^2 + (1*3-3)^2))$

- W = 2, cost(W) = 4.67

  $\frac{1}{3}((2*1-1)^2 + (2*2-2)^2 + (2*3-3)^2))$

- W = 3, cost(W) = 18.67

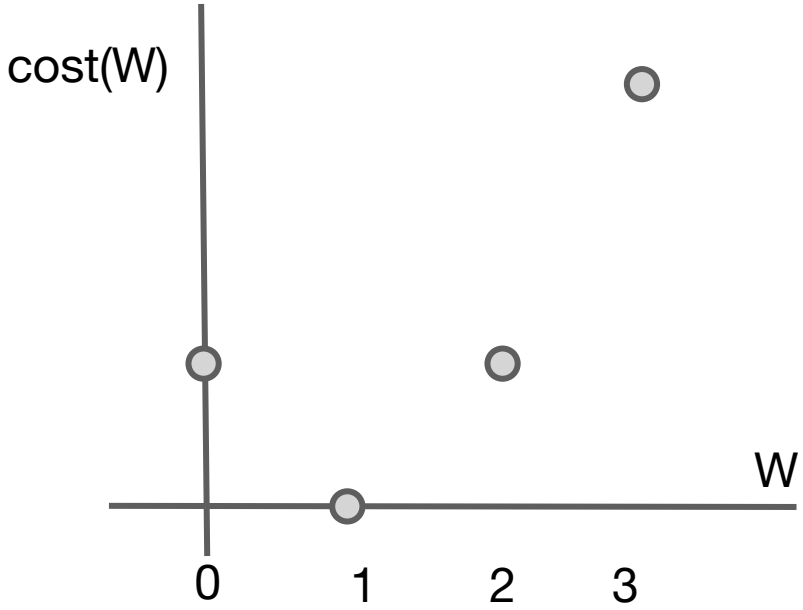
  $\frac{1}{3}((3*1-1)^2 + (3*2-2)^2 + (3*3-3)^2))$

What cost(W) looks like?

- W = 0, cost(W) = 4.67
- W = 1, cost(W) = 0
- W = 2, cost(W) = 4.67
- W = 3, cost(W) = 18.67

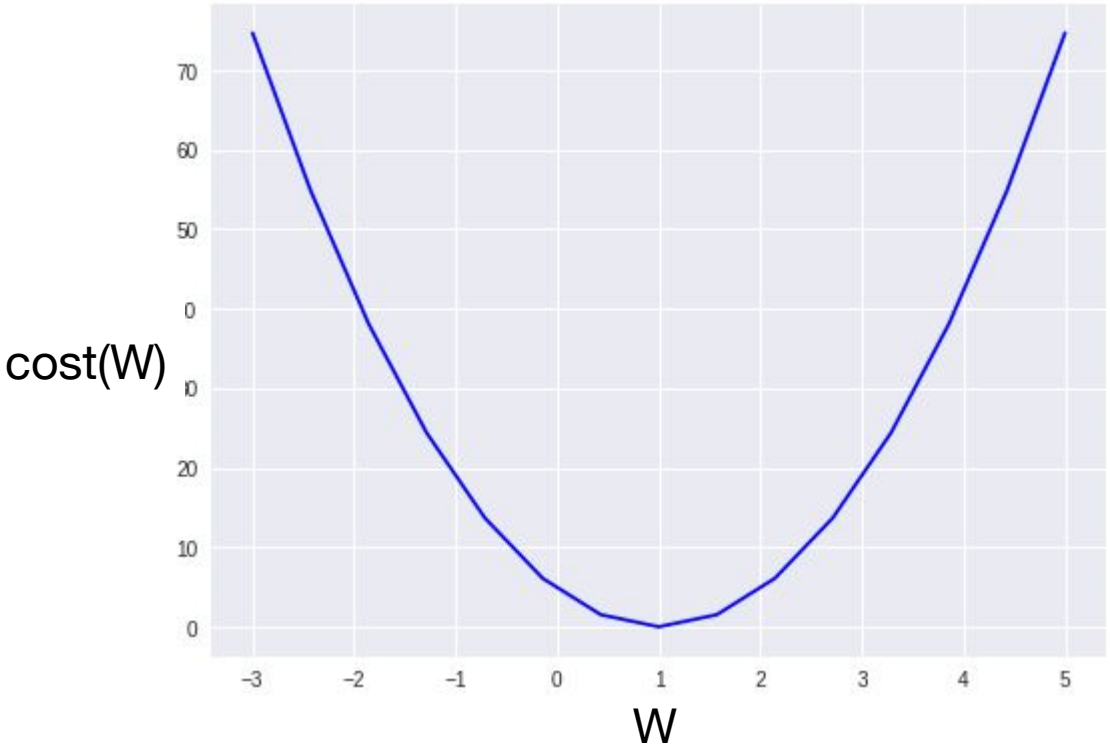
What cost(W) looks like?

- W = 0, cost(W) = 4.67
- W = 1, cost(W) = 0
- W = 2, cost(W) = 4.67
- W = 3, cost(W) = 18.67



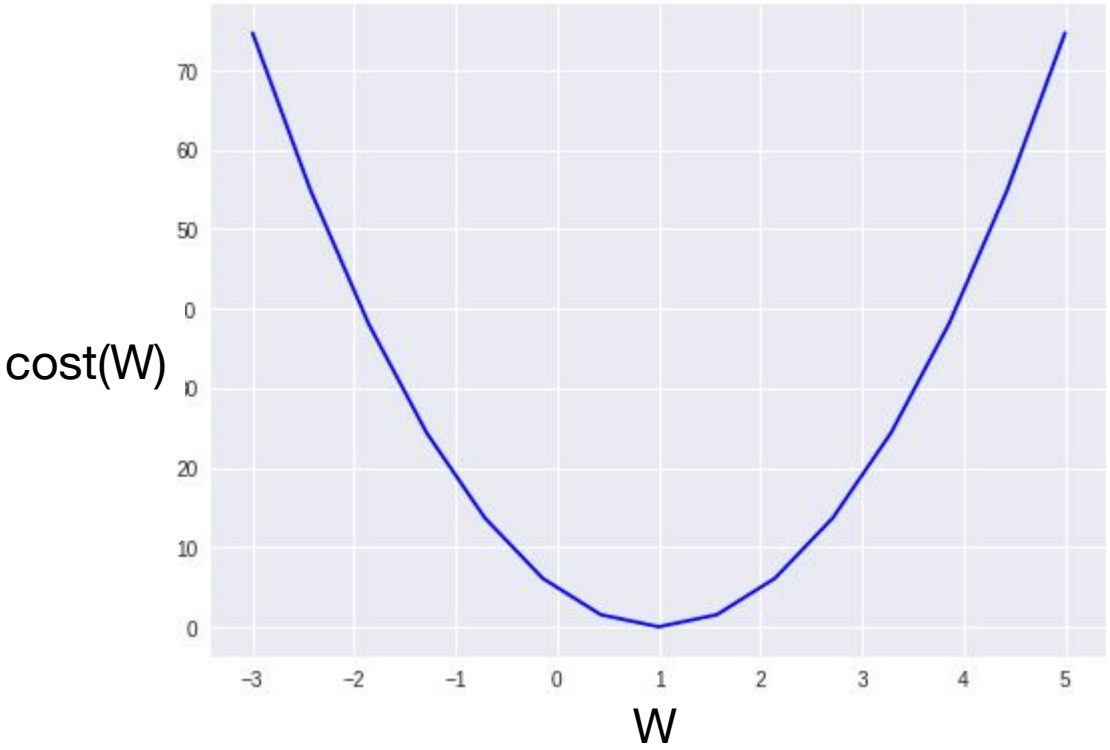
What cost(W) looks like?

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



How to minimize cost?

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

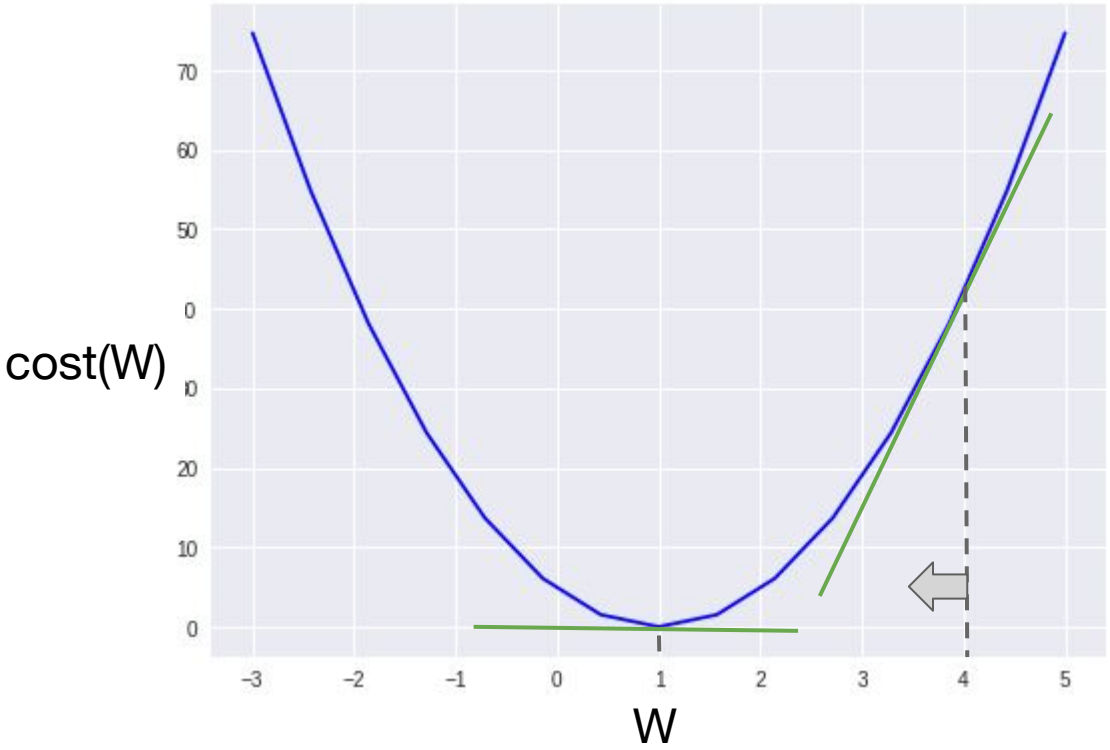


Gradient descent algorithm

- Minimize cost function
- Gradient descent is used many minimization problems
- For a given cost function, cost (W, b), it will find W, b to minimize cost
- It can be applied to more general function: *cost (w1, w2, ...)*

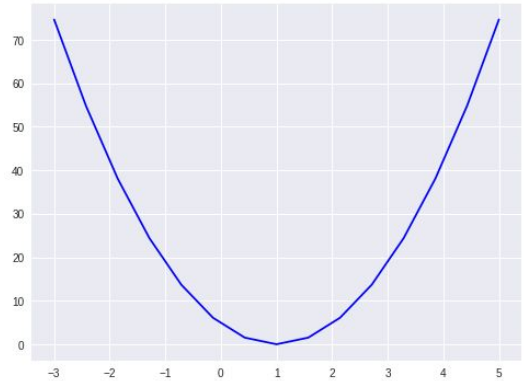
How it works?

How would you find the lowest point?



기울기가 0이 되는 점을 찾는다

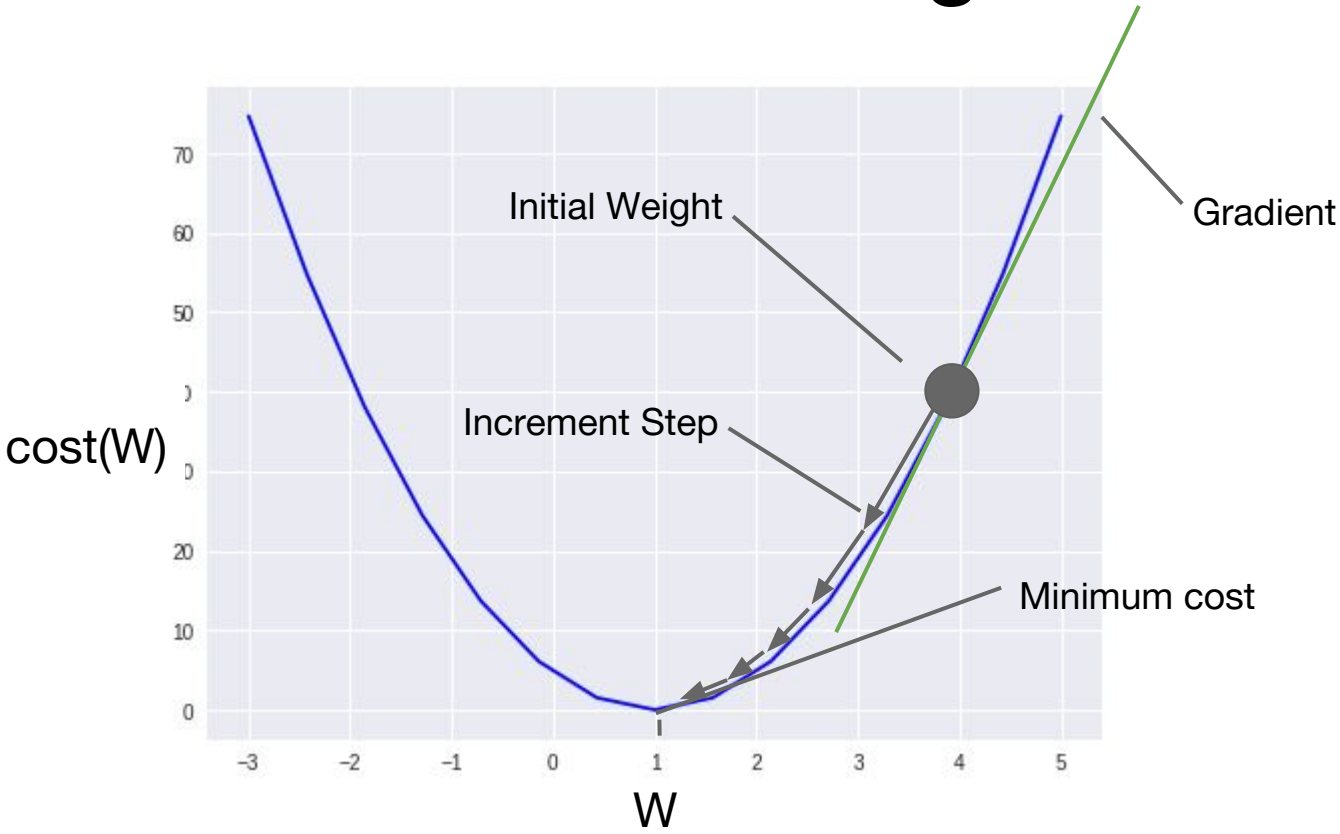
How it works?



- Start with initial guesses
  - Start at 0,0 (or any other value)
  - Keeping changing W and b a little bit to try and reduce cost(W, b)
- Each time you change the parameters, you select the gradient which reduces cost(W, b) the most possible
- Repeat
- Do so until you converge to a local minimum
- Has an interesting property
  - Where you start can determine which minimum you end up

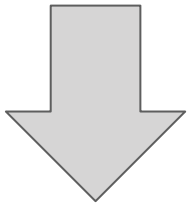
http://www.holehouse.org/mlclass/01_02_Introduction_regression_analysis_and_gr.html

Gradient descent algorithm



Formal definition

$$cost(W, b) = \frac{1}{m} \sum_{i=1}^{m} \left(H(x_i) - y_i \right)^2$$



$$cost(W, b) = \frac{1}{2m} \sum_{i=1}^{m} \left(H(x_i) - y_i \right)^2$$

미분 후 계산식을 간단히 하기 위해
(m값은 cost에 영향을 주지 않는다)

Formal definition

$$W := W - \alpha \frac{\partial}{\partial W} \frac{1}{2m} \sum_{i=1}^{m} (W(x_i) - y_i)^2$$

$$W := W - \alpha \frac{1}{2m} \sum_{i=1}^{m} 2(W(x_i) - y_i) x_i$$

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

Formal definition

$$cost(W, b) = \frac{1}{2m} \sum_{i=1}^{m} \left(H(x_i) - y_i \right)^2$$

$$W := W - \alpha \frac{\partial}{\partial W} cost(W)$$

Derivative Calculator

Calculate derivatives online — *with steps and graphing!*

Also check the **Integral Calculator**!
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Ableitungsrechner auf Deutsch

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Calculate the Derivative of ...

x^2+b

Go!

CLR + − × ÷ ^ √ ( )

This will be calculated:

$$\frac{d}{dx}\left[x^2+b\right]$$

Not what you mean? *Use parentheses!* Set differentiation variable and order in "*Options*".

About | Help | Examples | Options | Practice

The Derivative Calculator lets you calculate derivatives of functions online — for free!

Our calculator allows you to check your solutions to calculus exercises. It helps you practice by showing you the full working (step by step differentiation).

The Derivative Calculator supports computing first, second, ..., fifth derivatives as well as differentiating functions with many variables (partial derivatives), implicit differentiation and calculating roots/zeros. You can also check your answers! Interactive graphs/plots help visualize and better understand the functions.

For more about how to use the Derivative Calculator, go to "*Help*" or take a look at the examples.

And now: Happy differentiating!

WolframAlpha computational intelligence.

d/dW (W * x) ^ 2

Browse Examples | Surprise Me

Derivative:

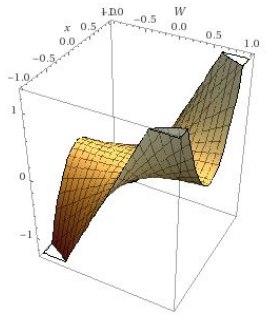
Step-by-step solution

$$\frac{\partial}{\partial W}\left((W\,x)^2\right) = 2\,W\,x^2$$

Open code

3D plot:

Show contour lines

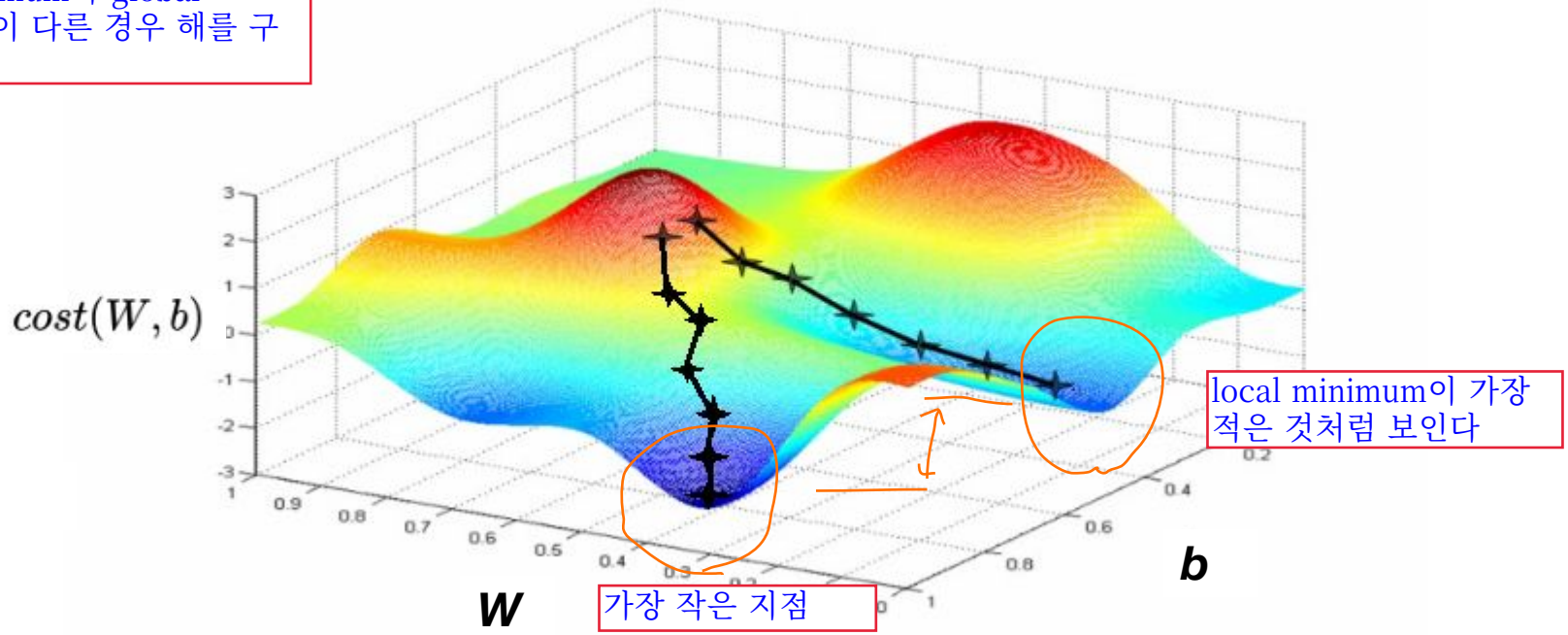


Gradient descent algorithm

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

Convex function

local minimum과 global minimum이 다른 경우 해를 구할수 없다

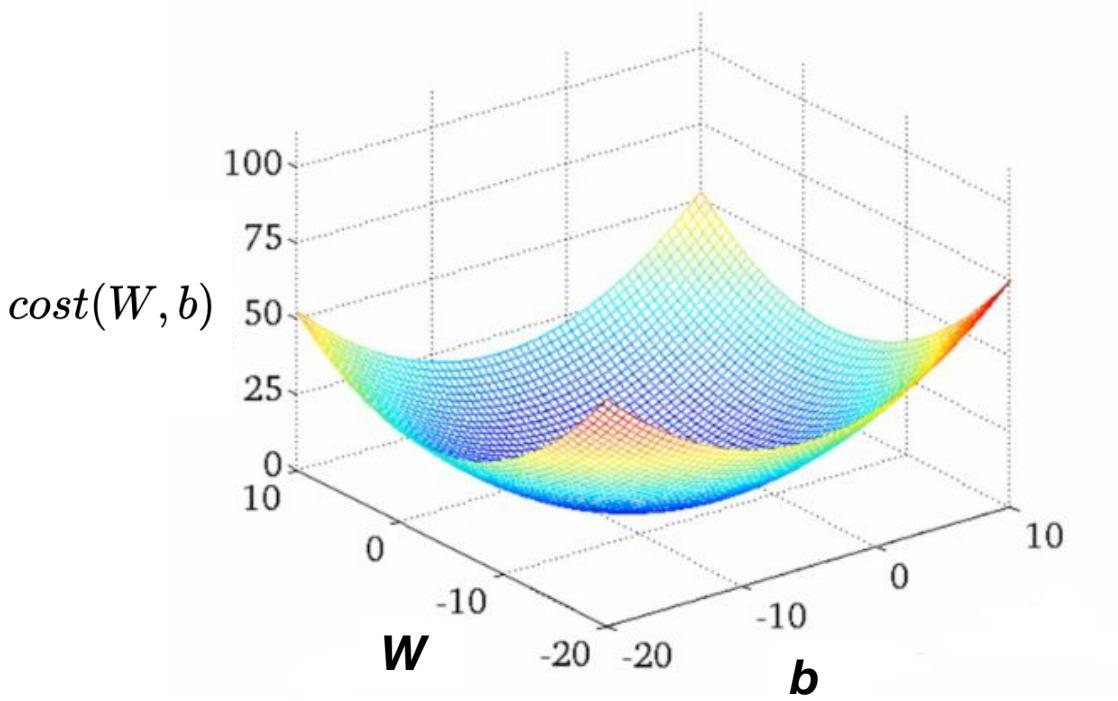


http://www.holehouse.org/mlclass/

Convex function

local minimum과 global minimum이 같을 경우 해를 구할수 있다

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



What’s Next?

- Multi-Variable Linear regression