

# ML/DL for Everyone Season2

with  TensorFlow

## 03 - How to minimize cost

Code: <https://github.com/deeplearningzerotoall/TensorFlow>

Slides: <http://bit.ly/2LQMKvk>

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# Hypothesis and Cost

Hypothesis  $H(x) = Wx + b$

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

# Simplified hypothesis

Hypothesis  $H(x) = Wx$

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

# What $\text{cost}(W)$ looks like?

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

- $W = 0$ ,  $\text{cost}(W) = ?$

x	y
1	1
2	2
3	3

# What cost(W) looks like?

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

- $W = 0$ ,  $\text{cost}(W) = 4.67$

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

x	y
1	1
2	2
3	3

# What $\text{cost}(W)$ looks like?

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

x	y
1	1
2	2
3	3

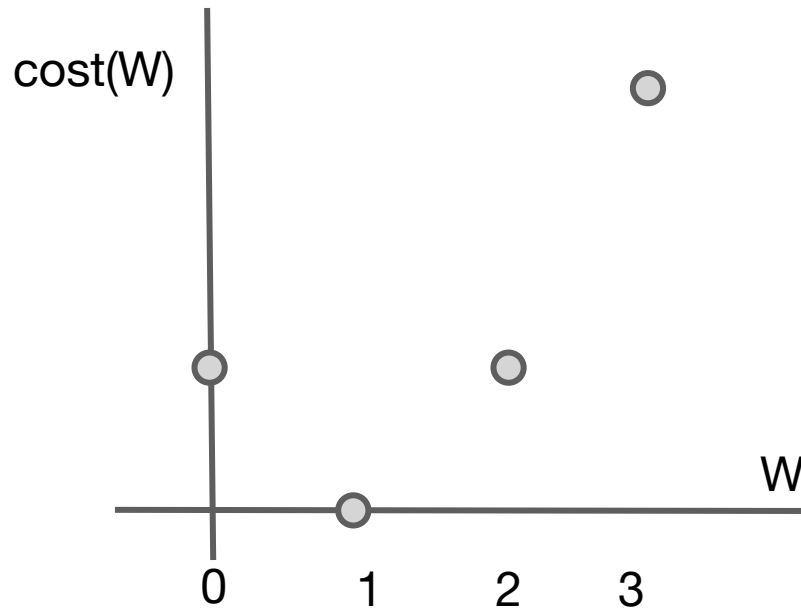
- $W = 0, \text{cost}(W) = 4.67$   
$$\frac{1}{3}((0 * 1 - 1)^2 + (0 * 2 - 2)^2 + (0 * 3 - 3)^2))$$
- $W = 1, \text{cost}(W) = 0$   
$$\frac{1}{3}((1 * 1 - 1)^2 + (1 * 2 - 2)^2 + (1 * 3 - 3)^2))$$
- $W = 2, \text{cost}(W) = 4.67$   
$$\frac{1}{3}((2 * 1 - 1)^2 + (2 * 2 - 2)^2 + (2 * 3 - 3)^2))$$
- $W = 3, \text{cost}(W) = 18.67$   
$$\frac{1}{3}((3 * 1 - 1)^2 + (3 * 2 - 2)^2 + (3 * 3 - 3)^2))$$

# What $\text{cost}(W)$ looks like?

- $W = 0, \text{cost}(W) = 4.67$
- $W = 1, \text{cost}(W) = 0$
- $W = 2, \text{cost}(W) = 4.67$
- $W = 3, \text{cost}(W) = 18.67$

# What $\text{cost}(W)$ looks like?

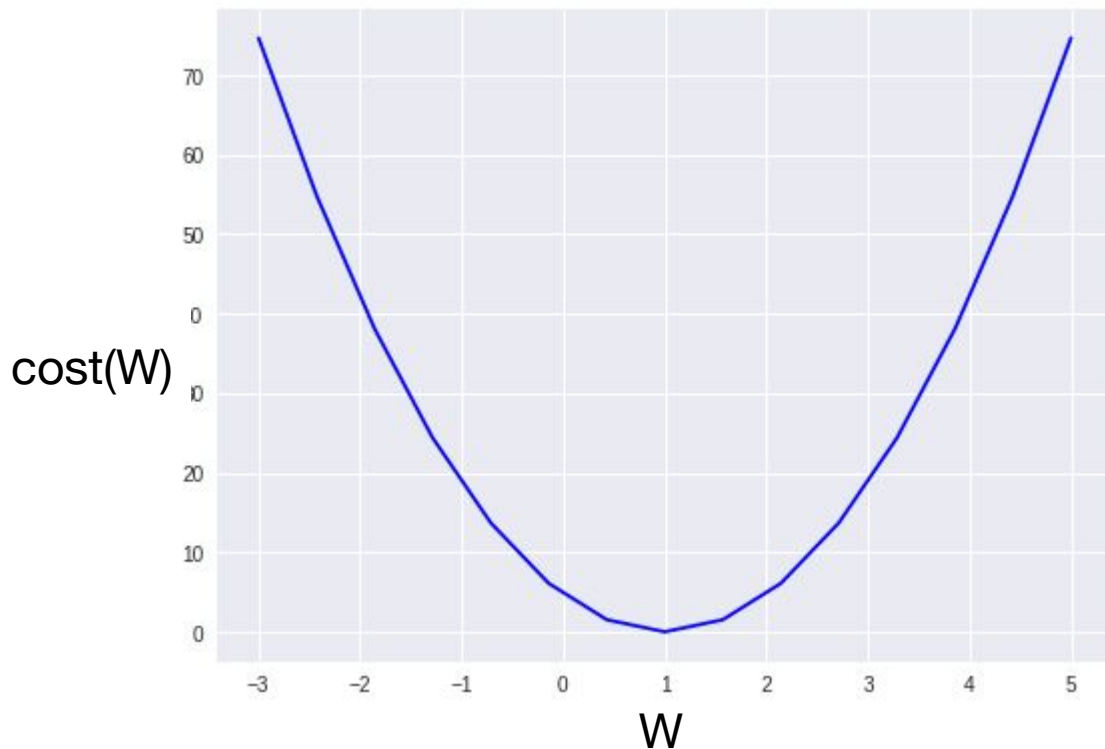
- $W = 0, \text{cost}(W) = 4.67$
- $W = 1, \text{cost}(W) = 0$
- $W = 2, \text{cost}(W) = 4.67$
- $W = 3, \text{cost}(W) = 18.67$





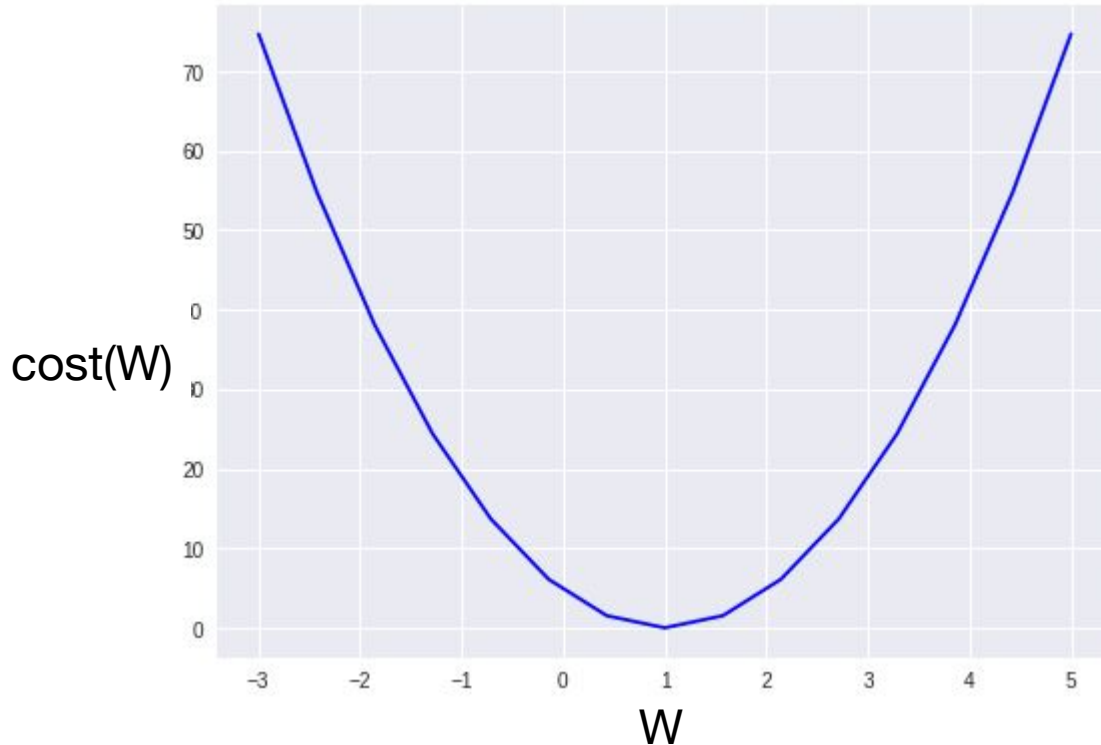
# What $\text{cost}(W)$ looks like?

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



# How to minimize cost?

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

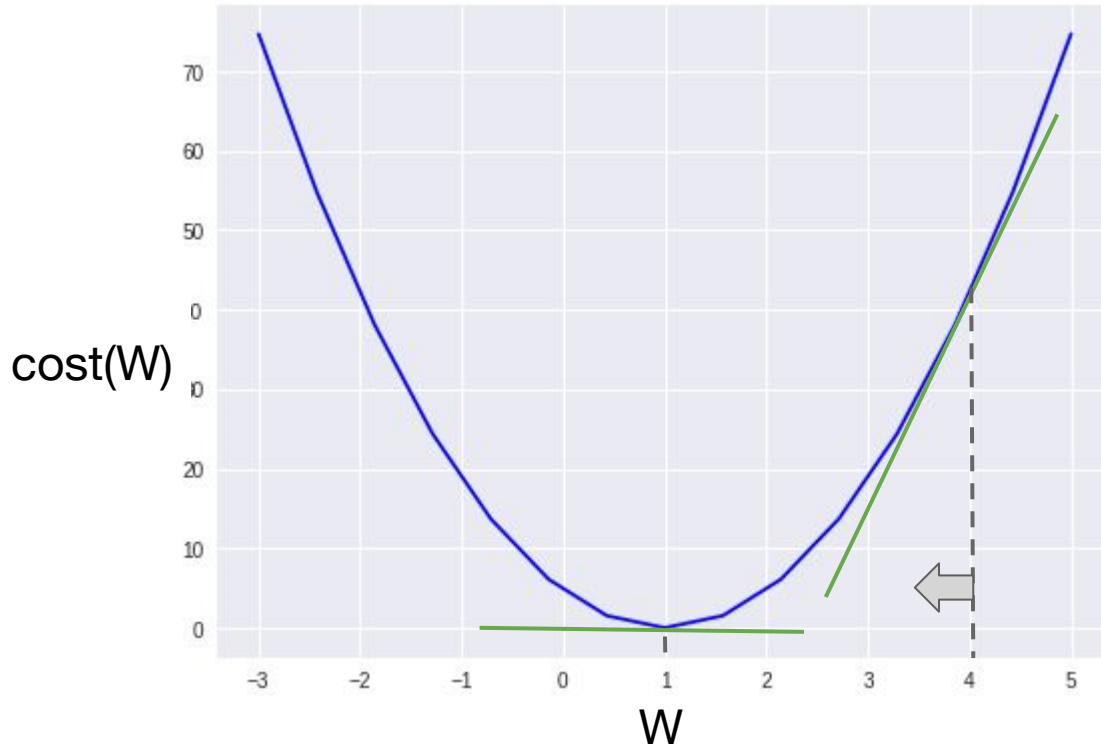


# Gradient descent algorithm

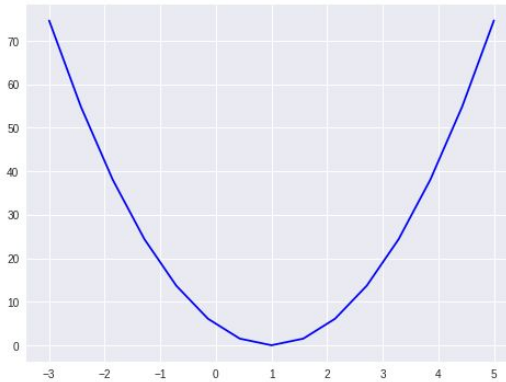
- Minimize cost function
- Gradient descent is used many minimization problems
- For a given cost function,  $\text{cost}(W, b)$ , it will find  $W, b$  to minimize cost
- It can be applied to more general function:  $\text{cost}(w_1, w_2, \dots)$

# How it works?

How would you find the lowest point?

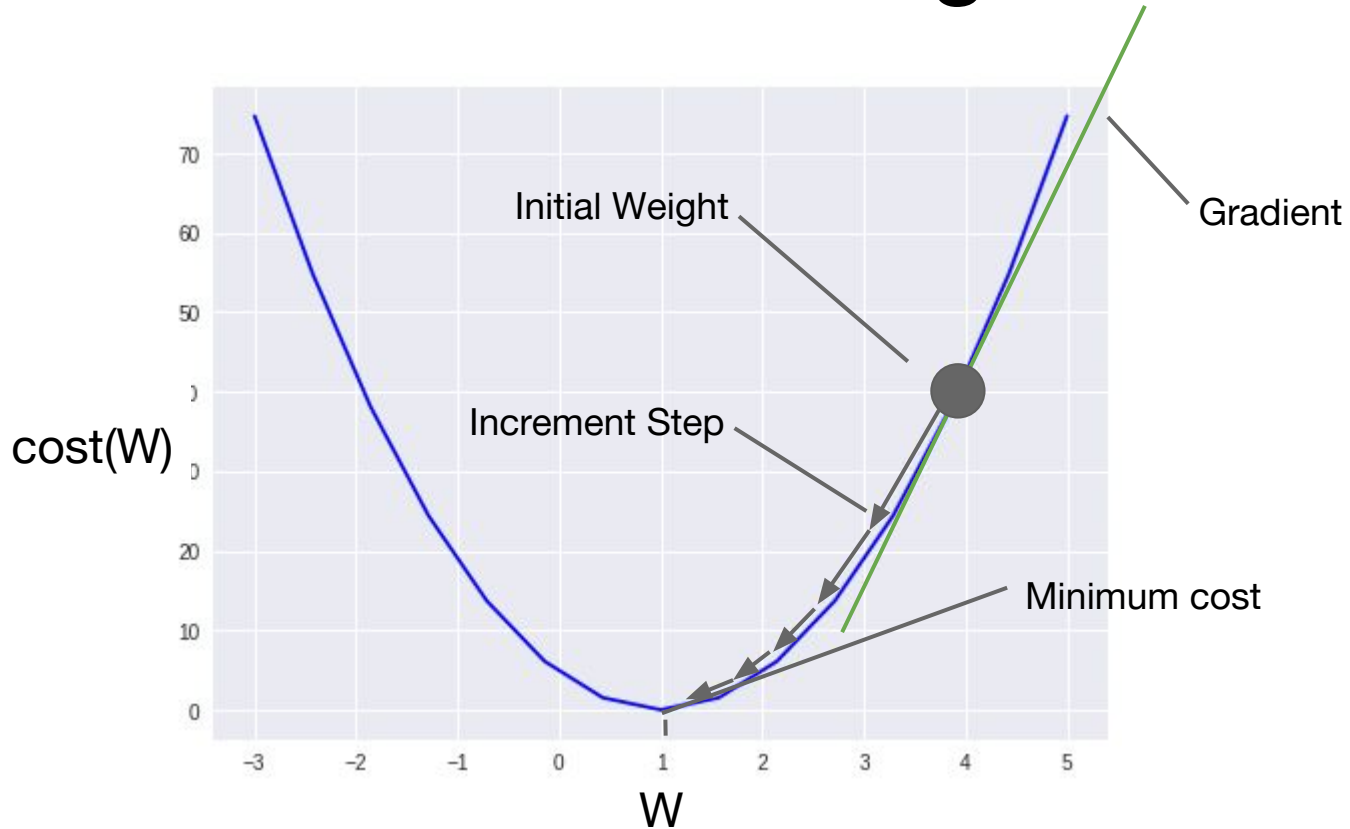


# How it works?



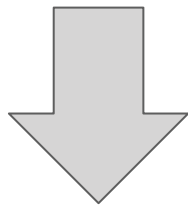
- Start with initial guesses
  - Start at 0,0 (or any other value)
  - Keeping changing  $W$  and  $b$  a little bit to try and reduce cost( $W, b$ )
- Each time you change the parameters, you select the gradient which reduces  $\text{cost}(W, b)$  the most possible
- Repeat
- Do so until you converge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

# Gradient descent algorithm



# Formal definition

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



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

# Formal definition

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

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


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



# Formal definition


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


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



# Derivative Calculator

Also check the [Integral Calculator!](#)


 [Calculadora de Derivadas en español](#)

 [Ableitungsrechner auf Deutsch](#)

Calculate derivatives online — with steps and graphing!

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✕

Calculate the Derivative of ...

$x^2 + b$

Go!

This will be calculated:

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

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!

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작심삼일





작심삼일 말고 작심 코딩.


(-)코딩it    온라인공부, 평가 없이 풀 령  
온라인으로 3일간 해보기  
작심코딩!


**WolframAlpha** computational intelligence.

$d/dW (W * x)^2$







[Browse Examples](#)


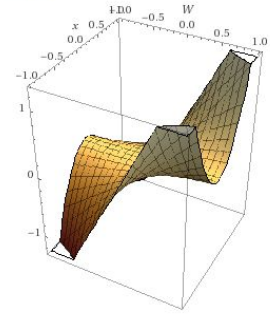
Derivative:

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


☒ Step-by-step solution

[Open code](#) 

3D plot:



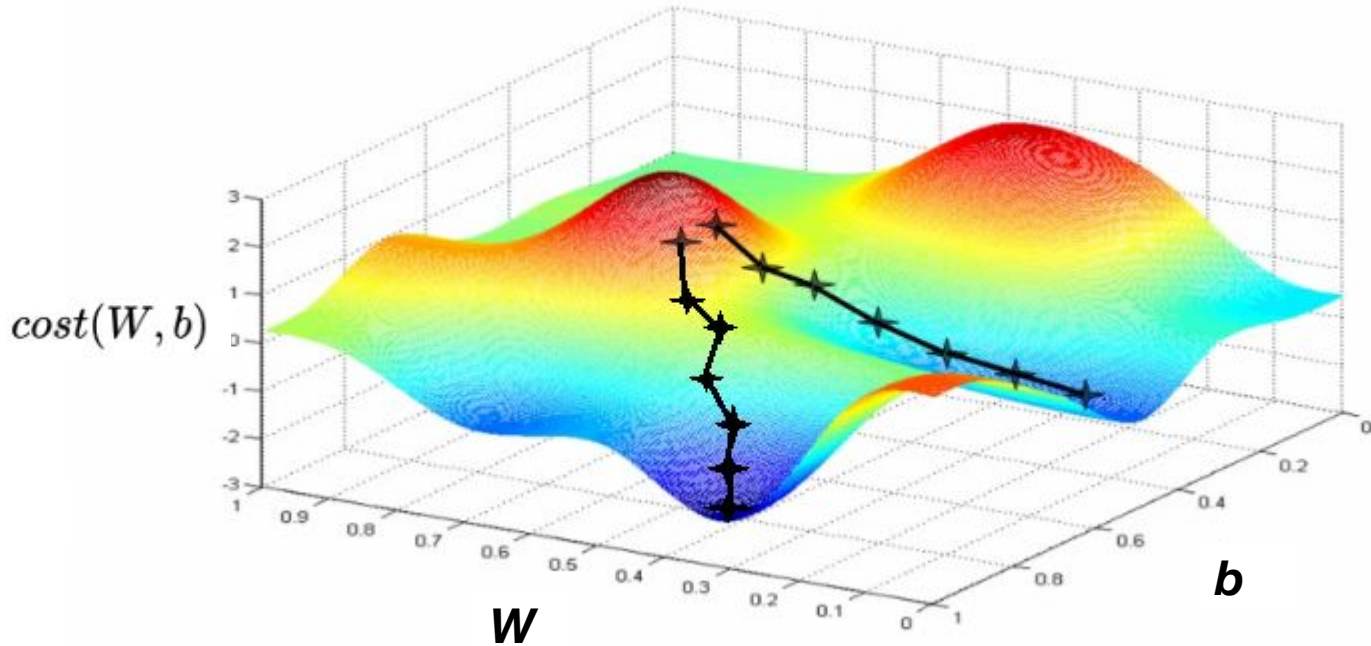
Show contour lines



# Gradient descent algorithm

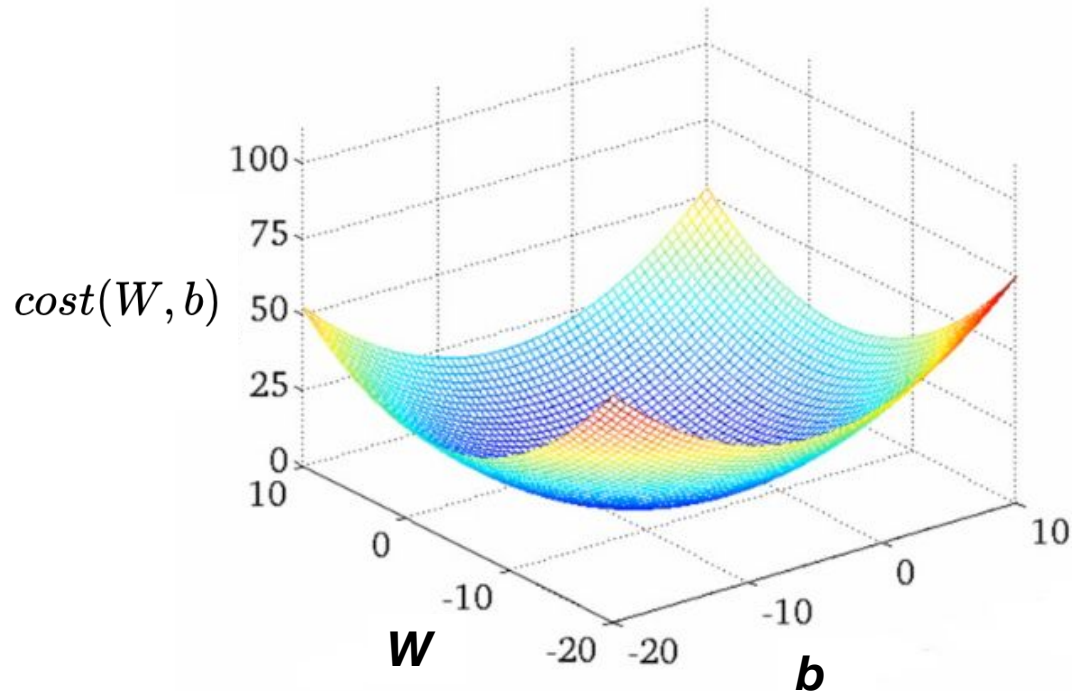
$$W := W - \alpha \frac{1}{m} \sum_{i=1}^m (W(x_i) - y_i) x_i$$

# Convex function



# Convex function

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



# What's Next?

- Multi-Variable Linear regression