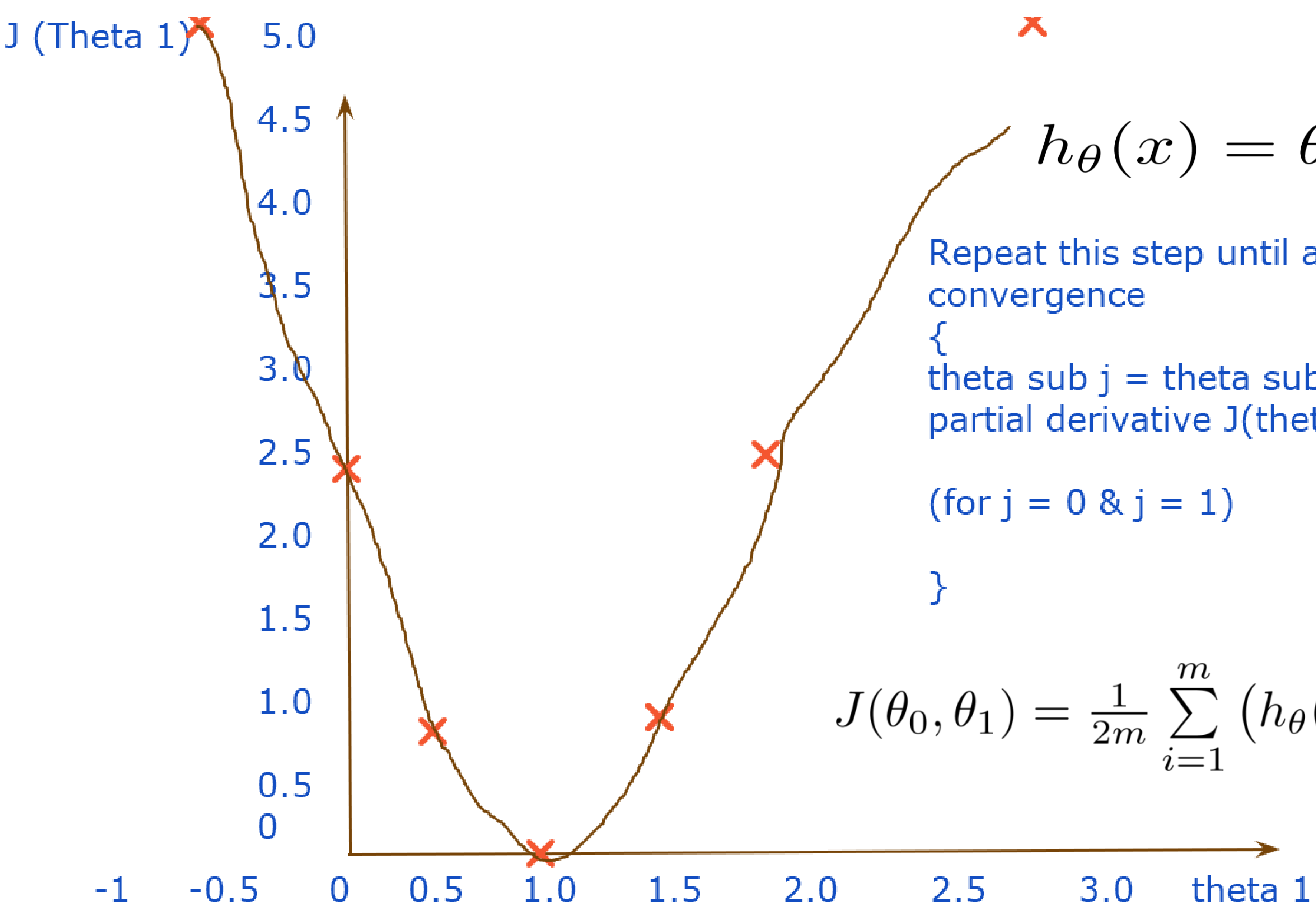

$$h_\theta(x) = \theta_1 x$$

Repeat this step until achieve convergence

{

theta sub j = theta sub j - alpha partial derivative J(theta's)/j

(for j = 0 & j = 1)

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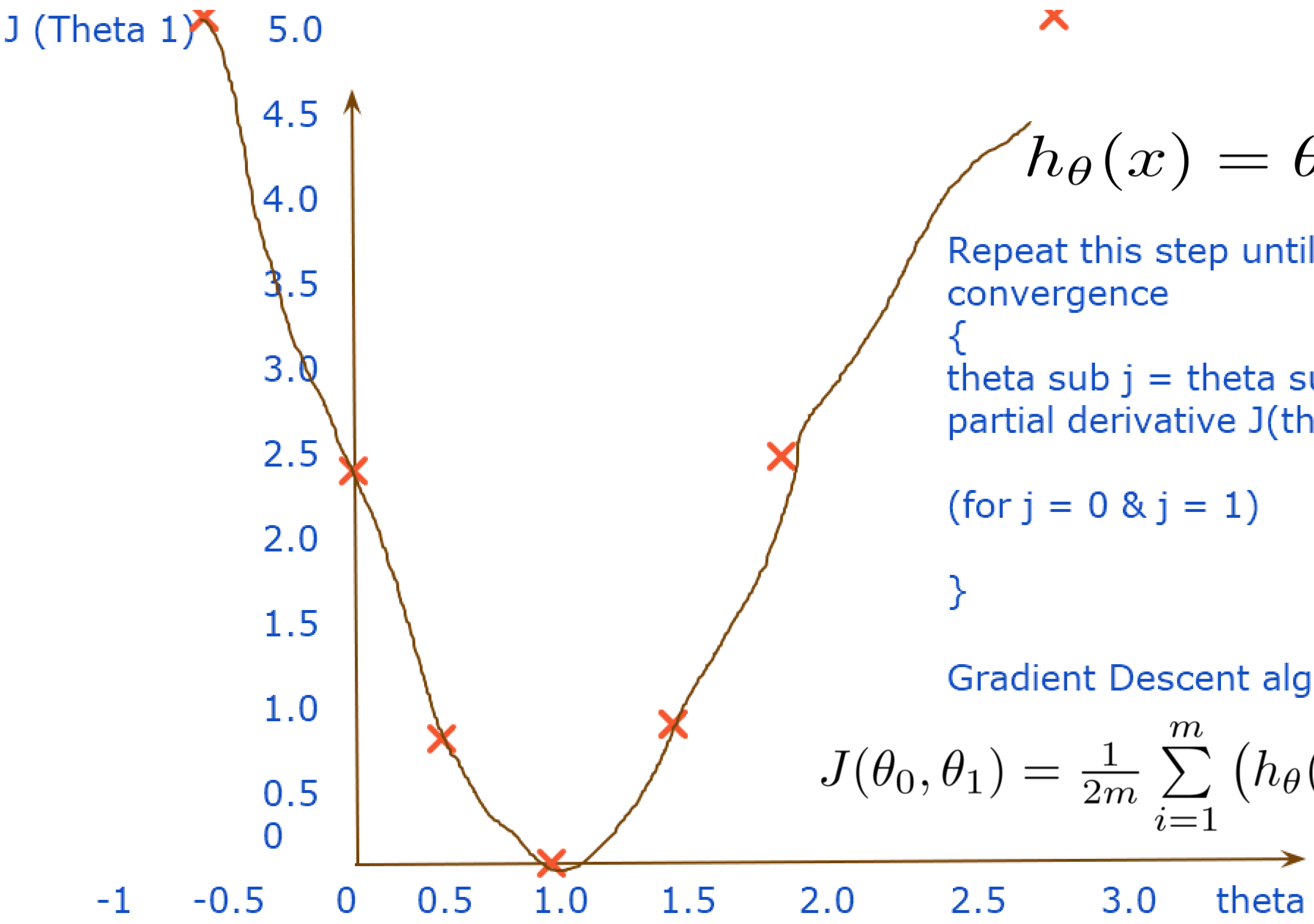
$$J(\theta_0, \theta_1) = \frac{1}{2m} \sum_{i=1}^{m} \left(h_\theta(x^{(i)}) - y^{(i)}\right)^2$$



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Gradient Descent algorithm

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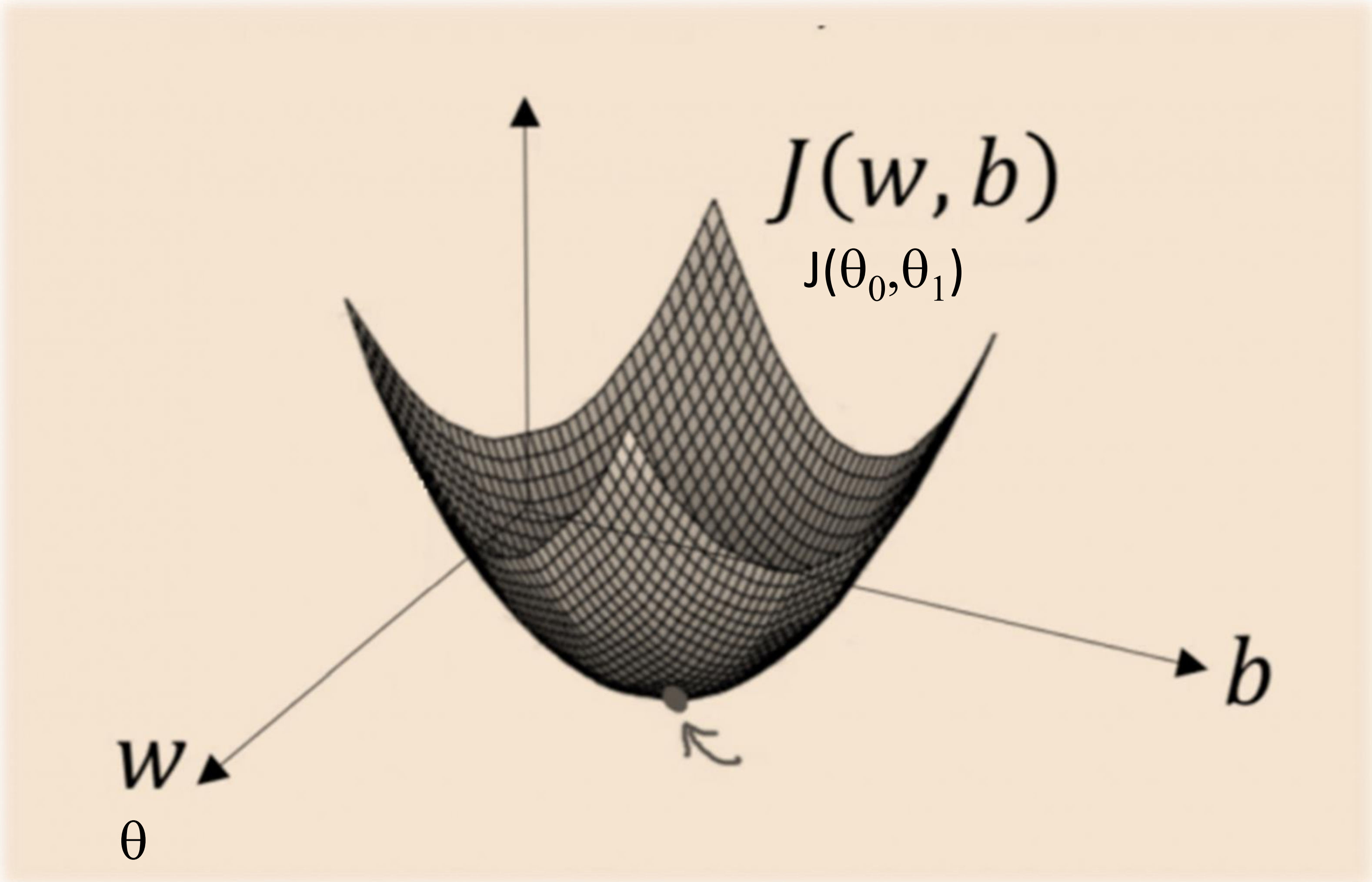
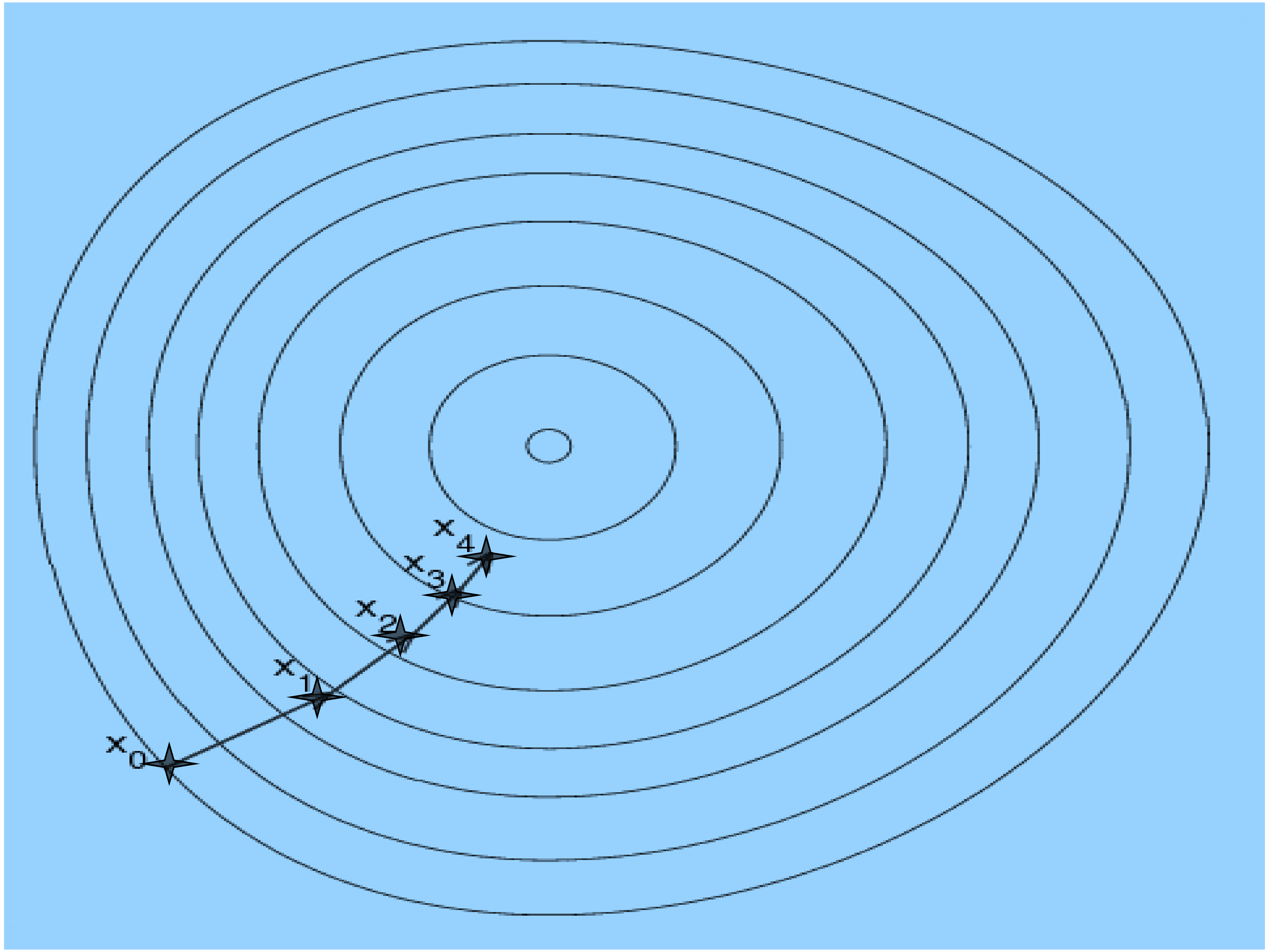
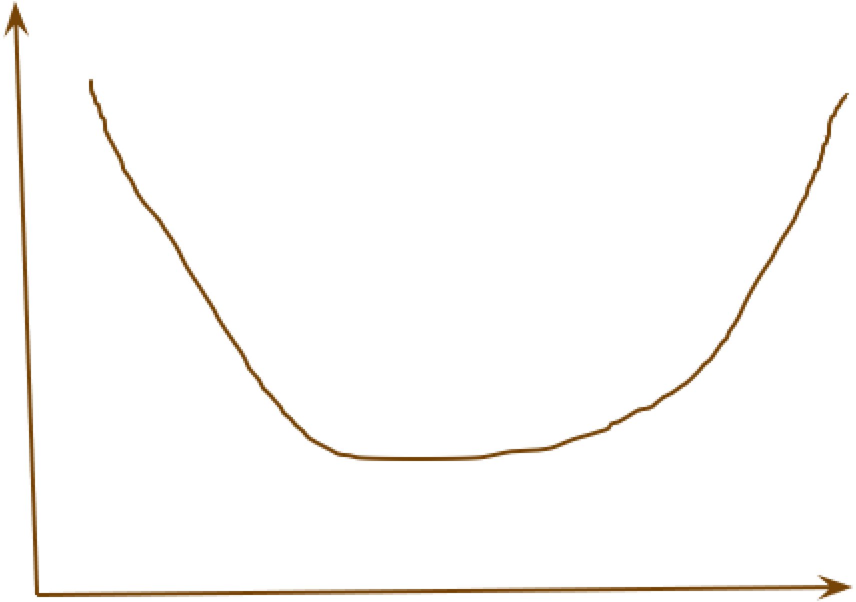

$J(w,b)$
$J(\theta_0,\theta_1)$
b
w
θ


x_0
x_1
x_2
x_3
x_4

Gradient Descent algorithm

Gradient Descent algorithm



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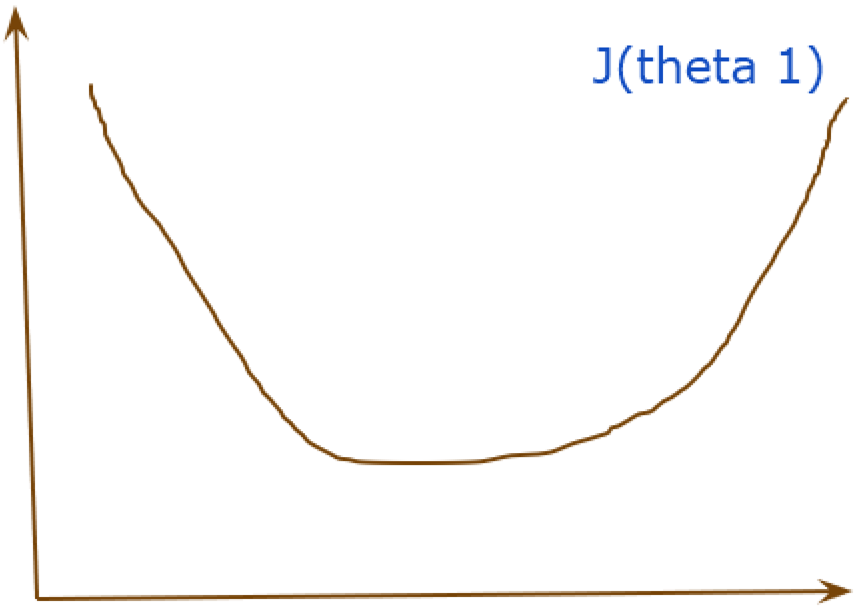

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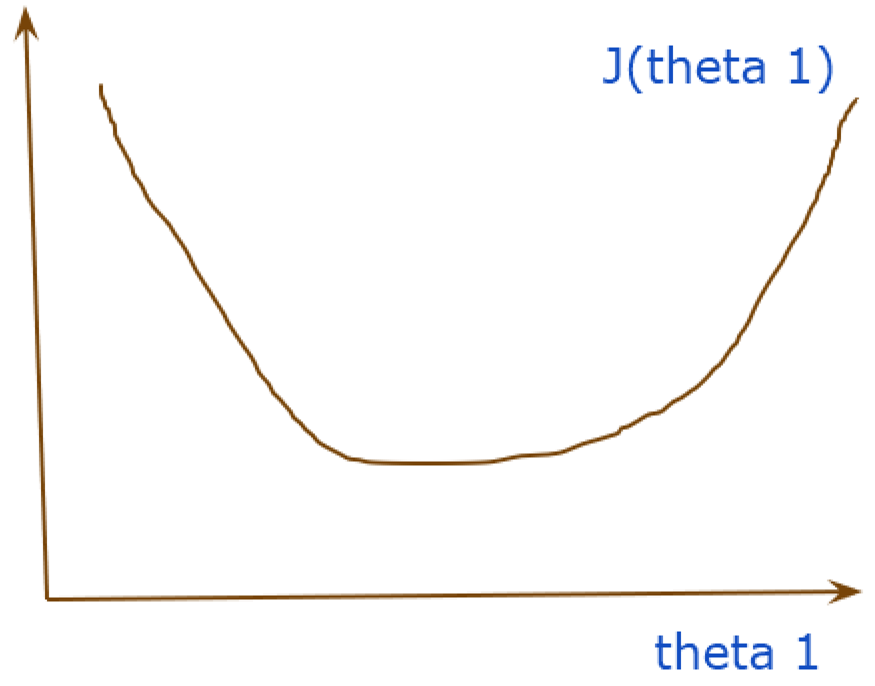

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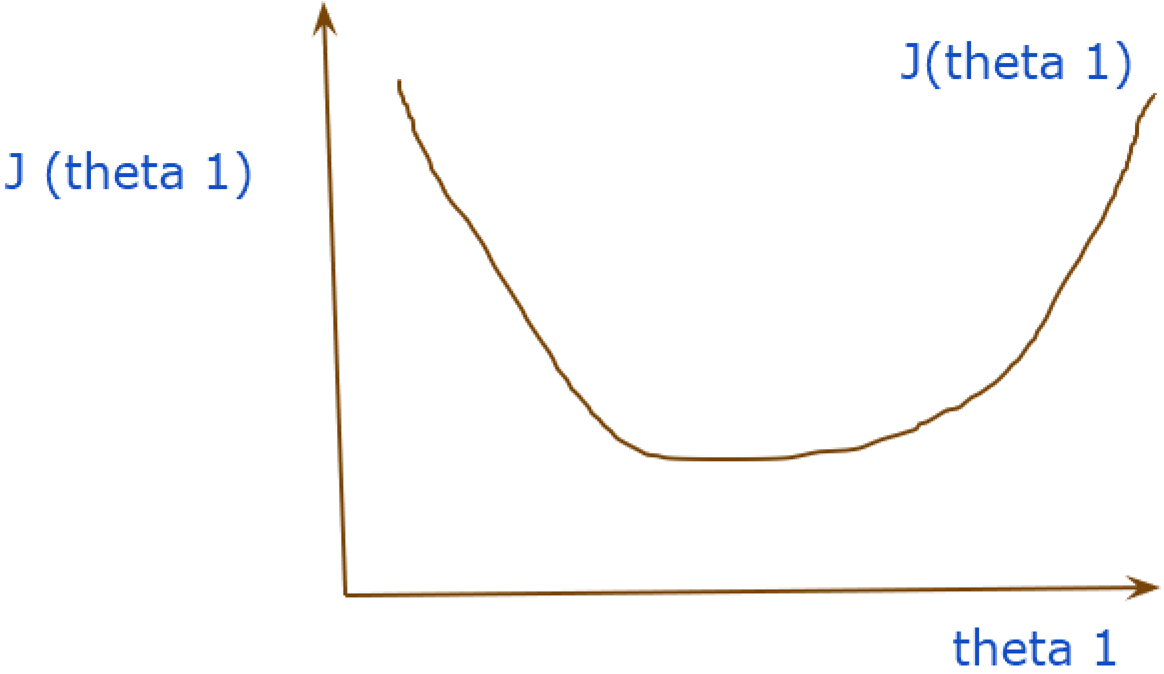

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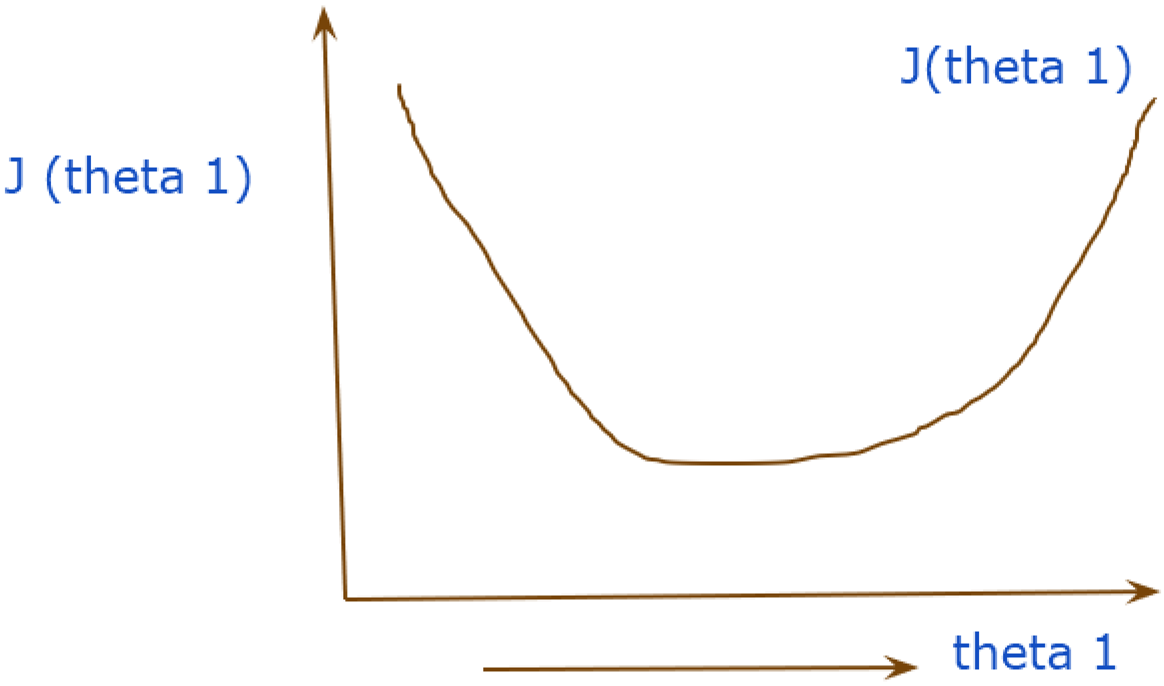

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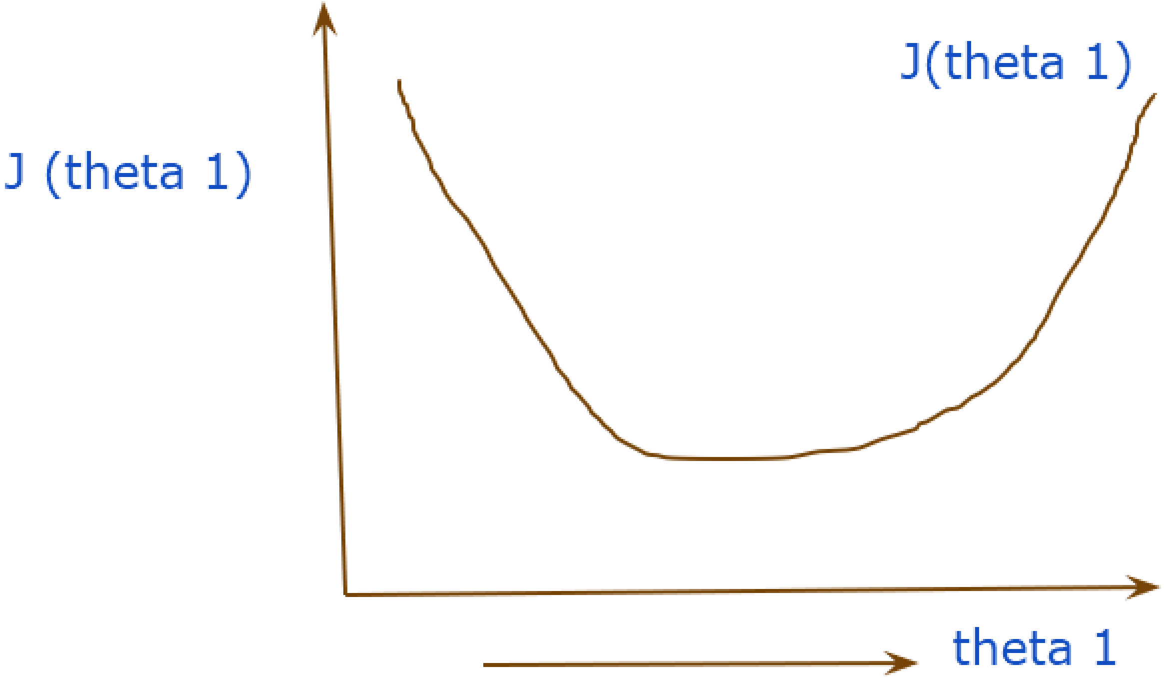
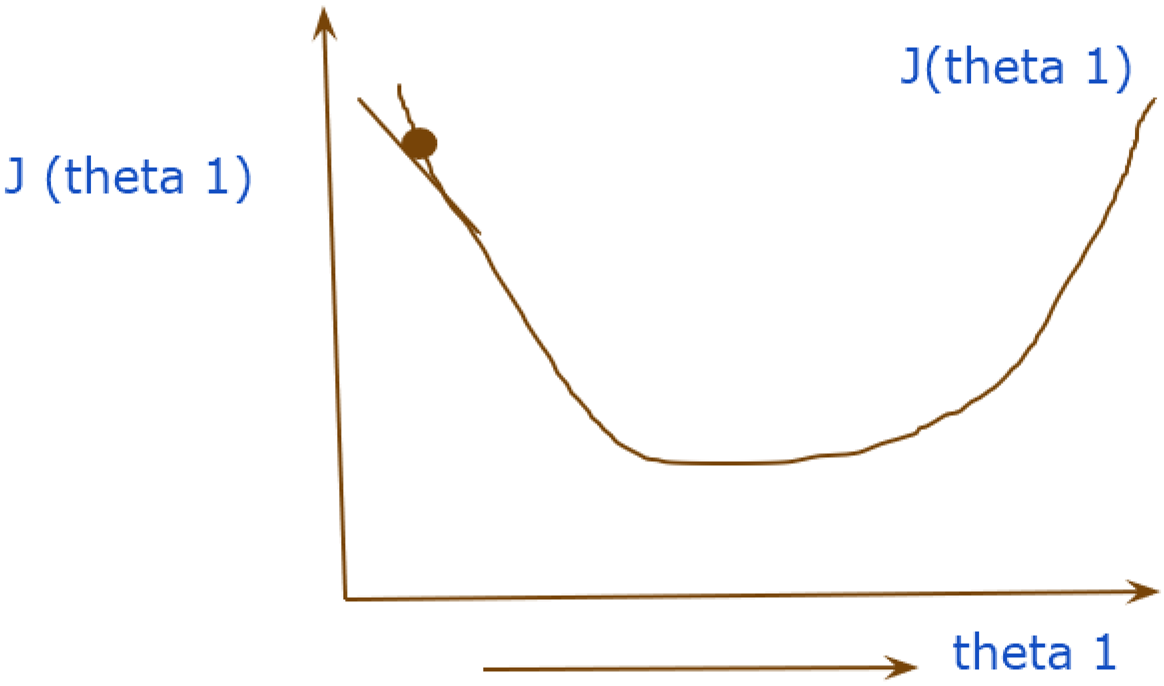


theta 1:= theta 1 - alpha(partial derivative J(theta 1)/theta 1)

Gradient Descent algorithm



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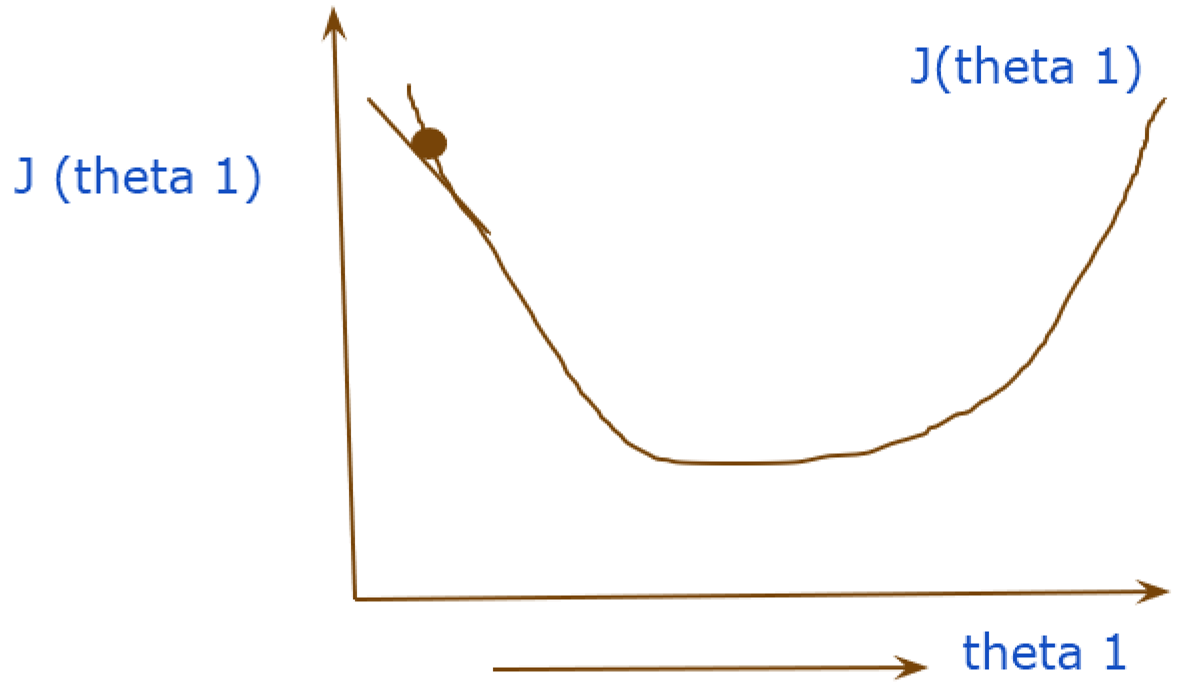

alpha: learning rate

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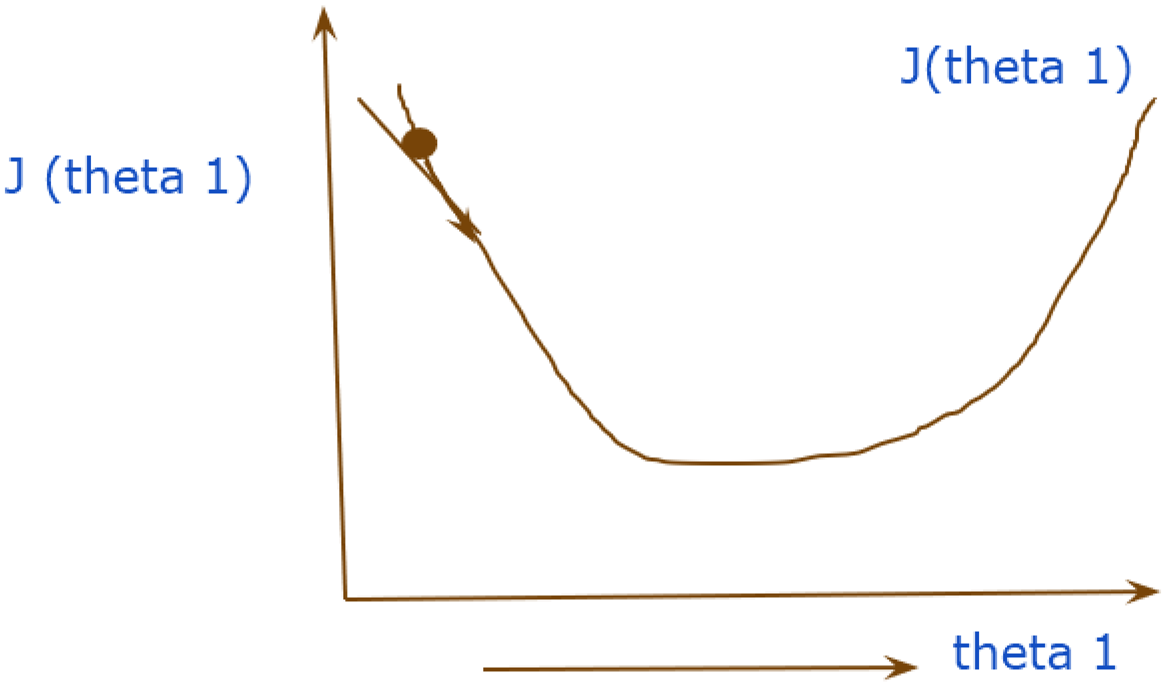

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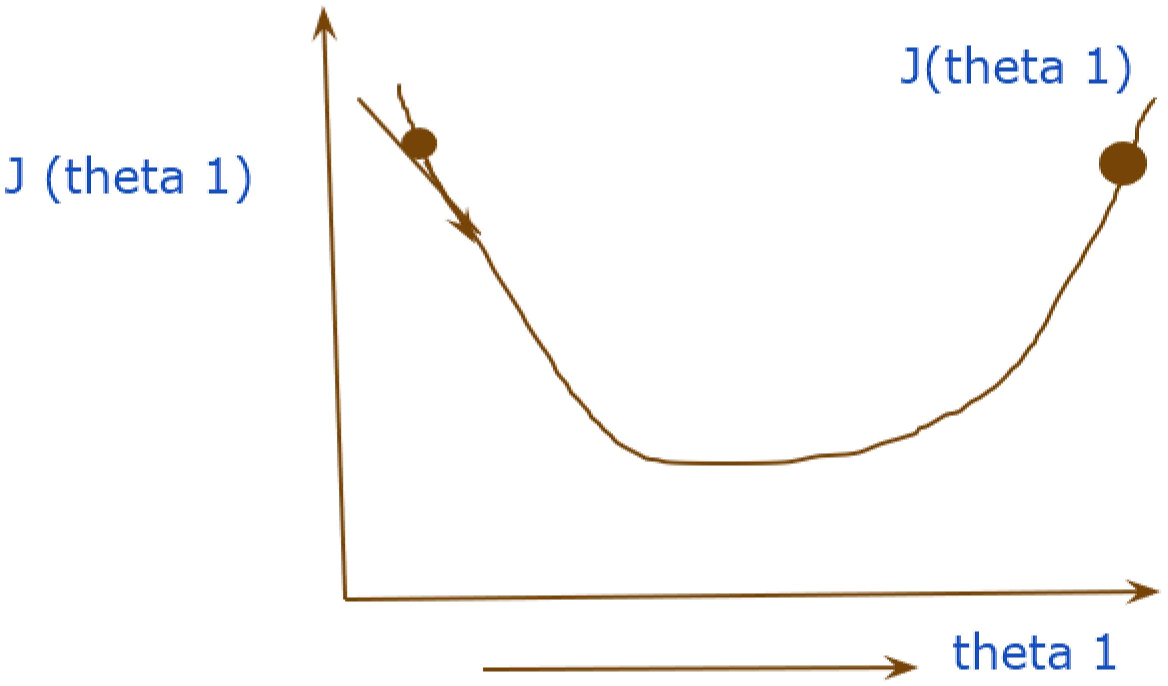
gradient: measures how much the output of a function changes if we change the input with small values

Gradient Descent algorithm



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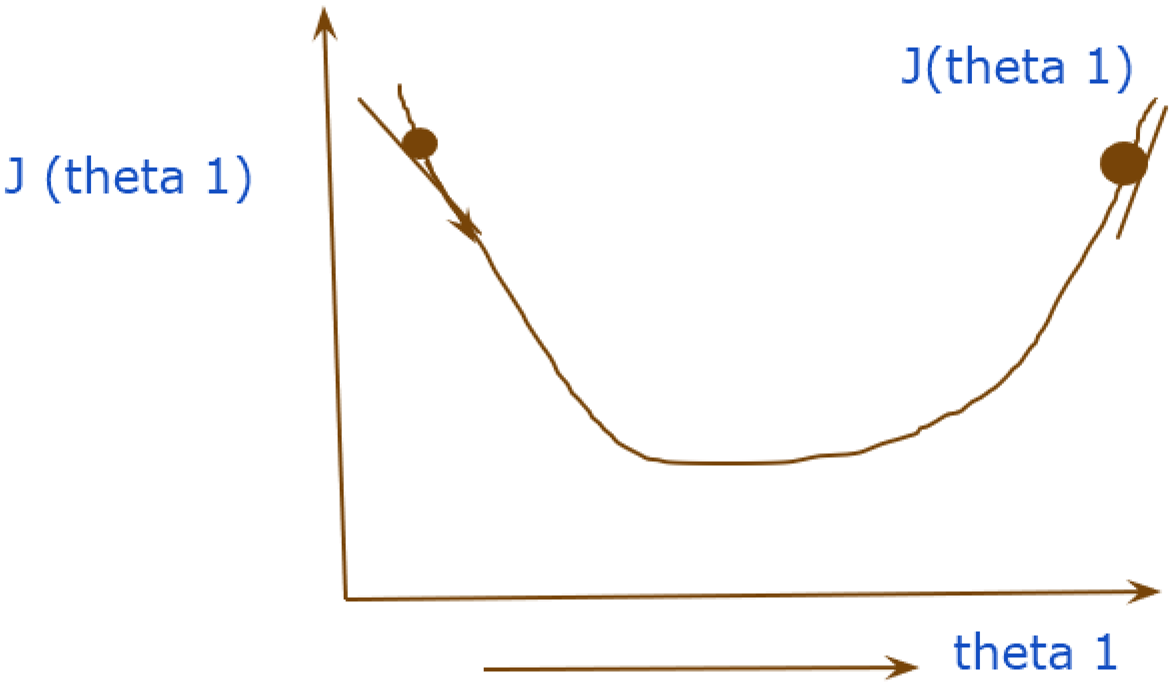

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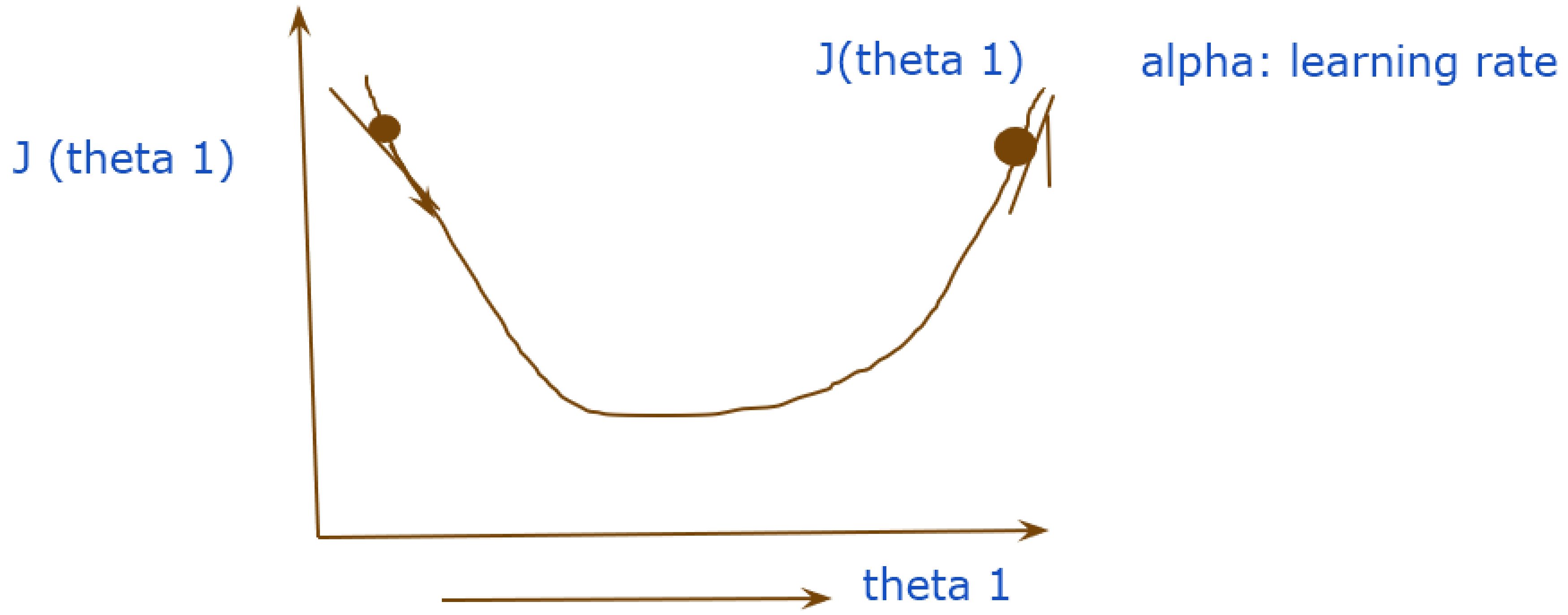

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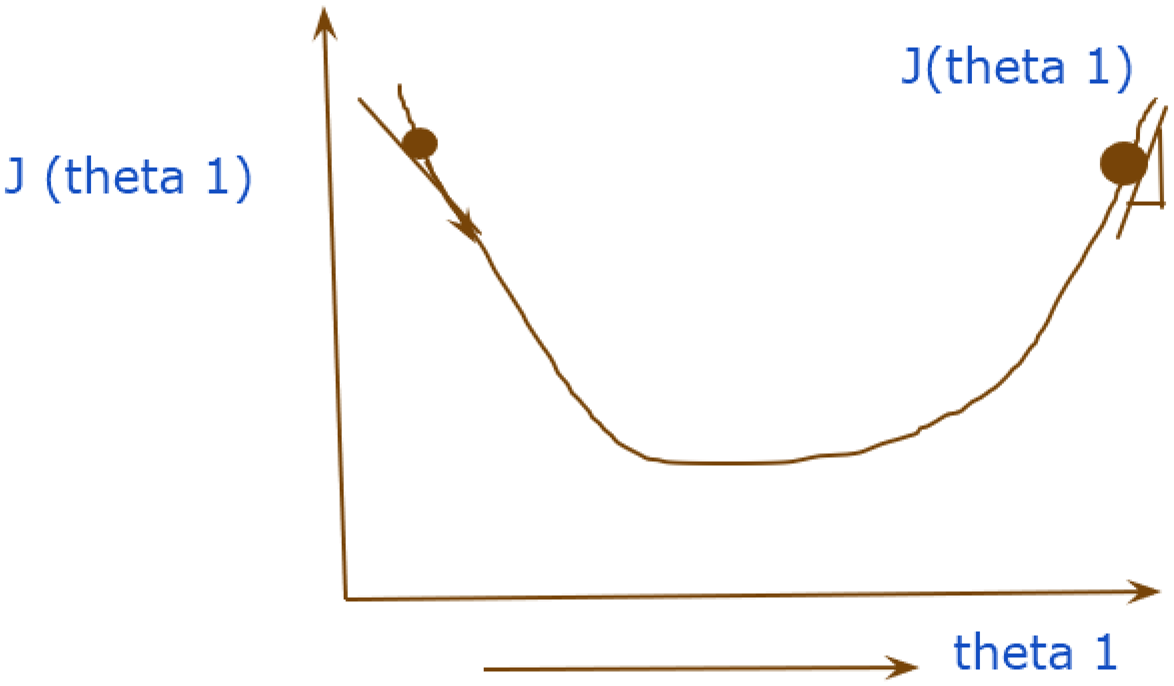

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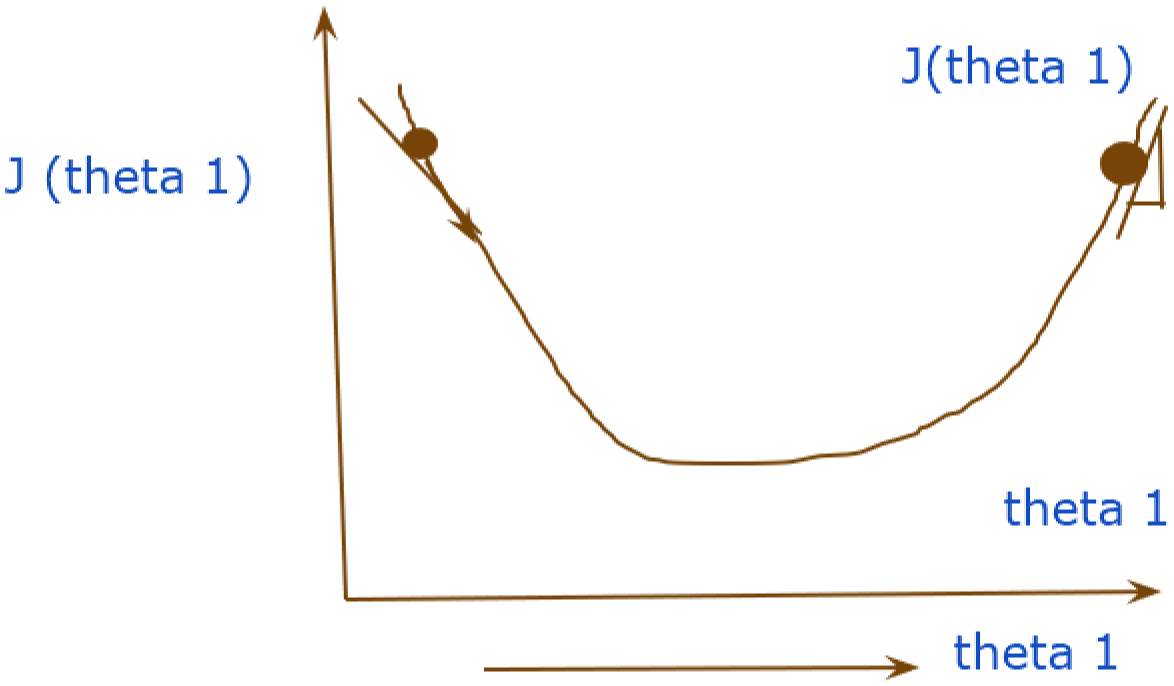

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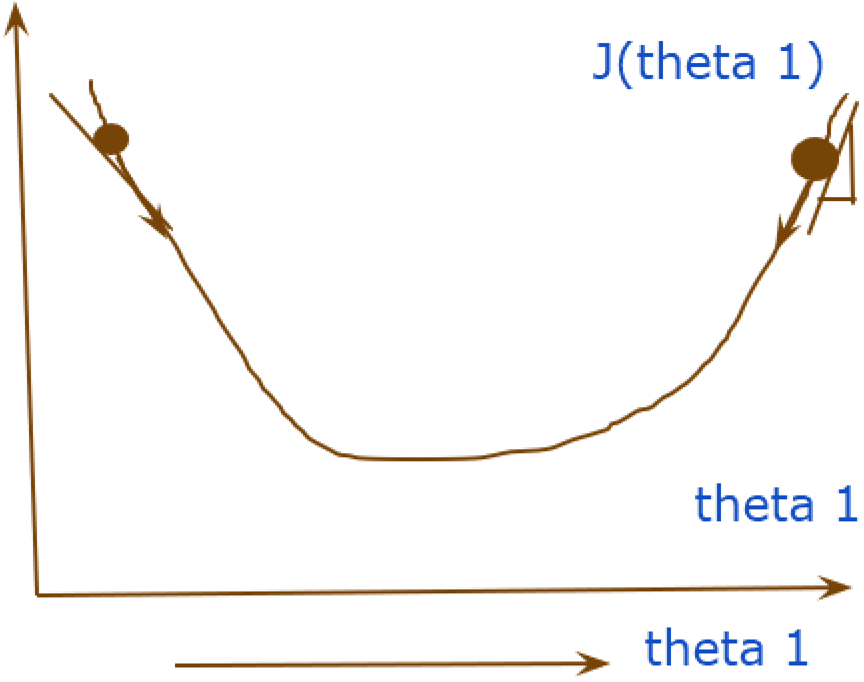
Gradient Descent algorithm

J (theta 1)



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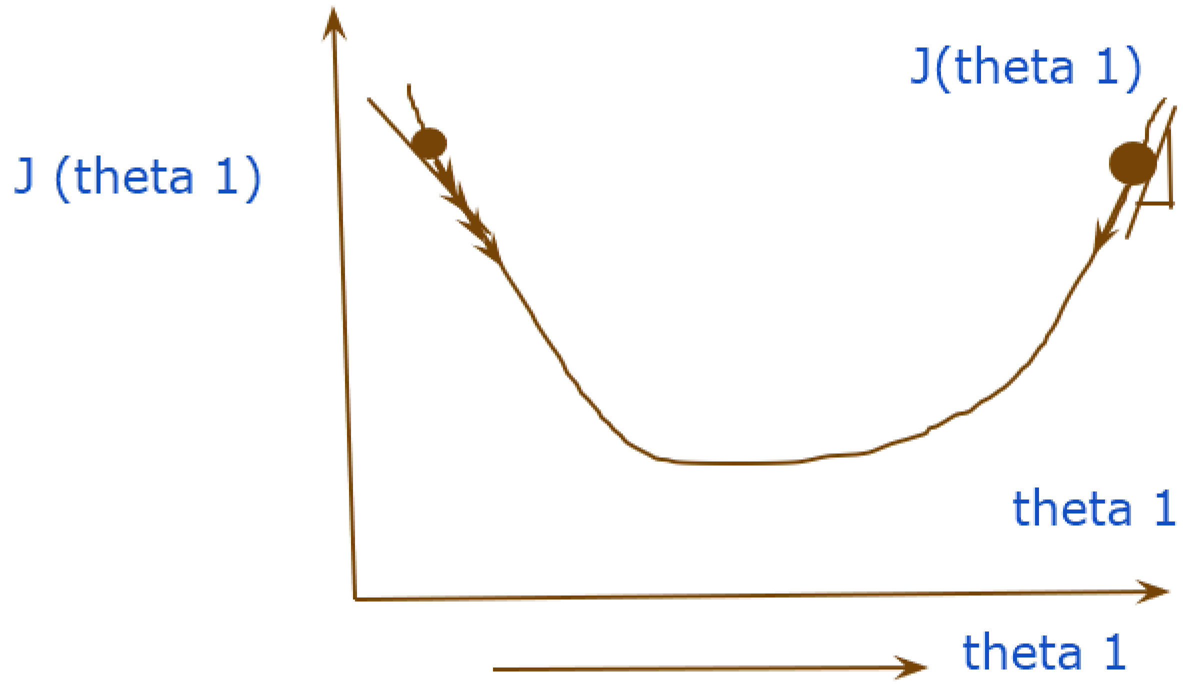

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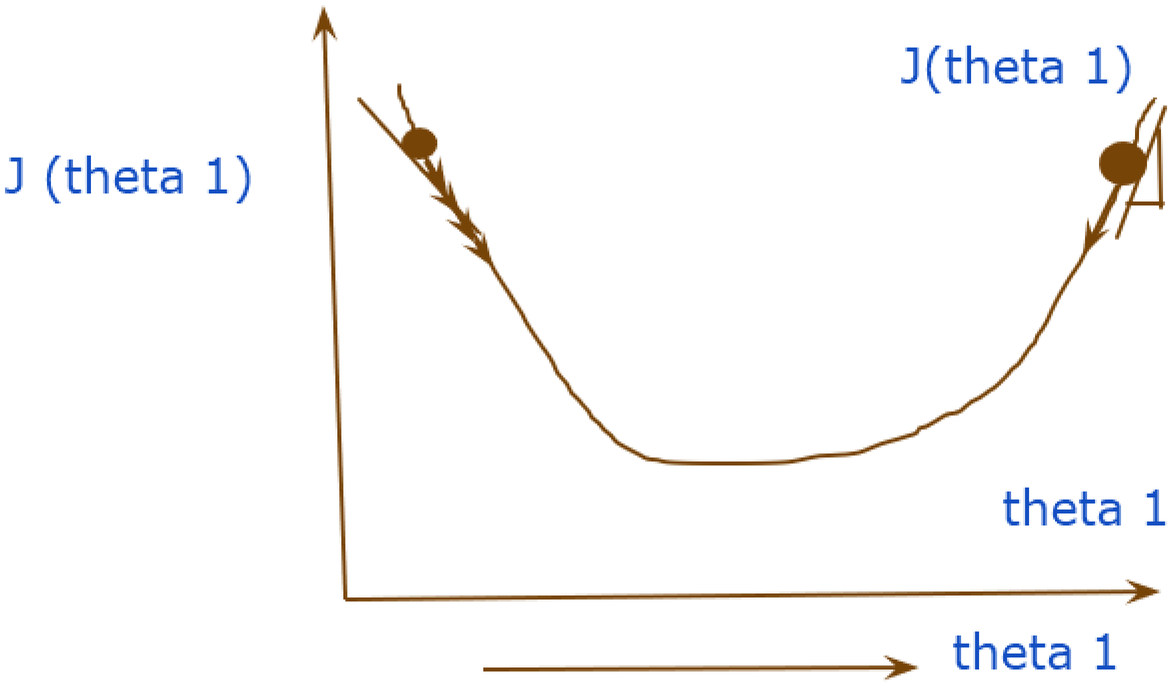

alpha: learning rate

alpha: very small

theta 1:= theta 1 - alpha (positive slope)

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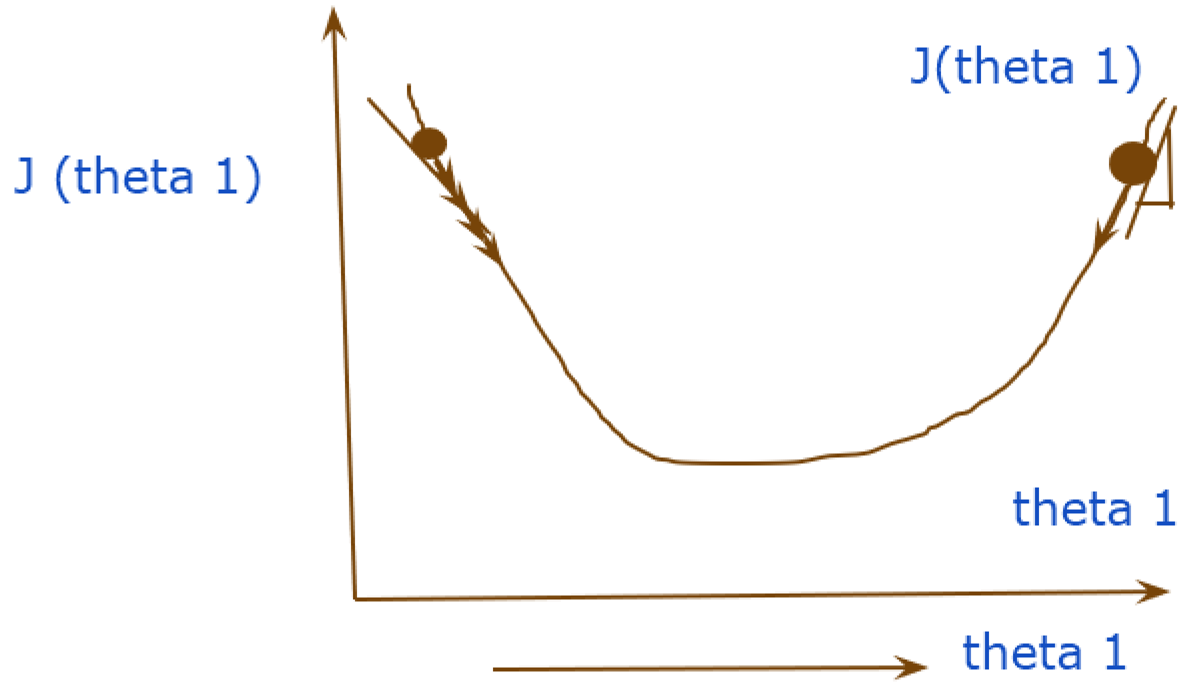

alpha: learning rate

alpha: very small

it will be very slow

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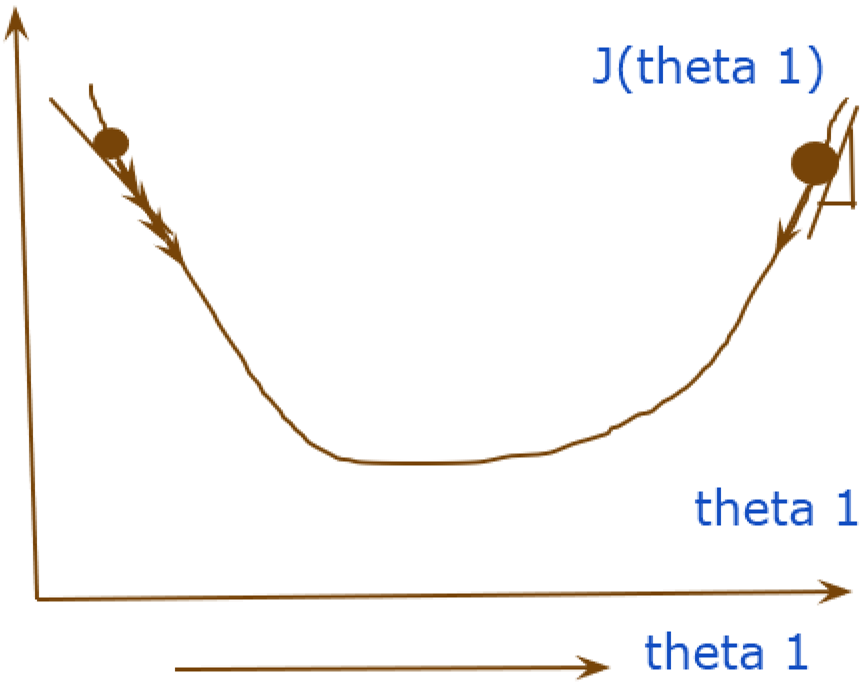
Gradient Descent algorithm

J (theta 1)



theta 1

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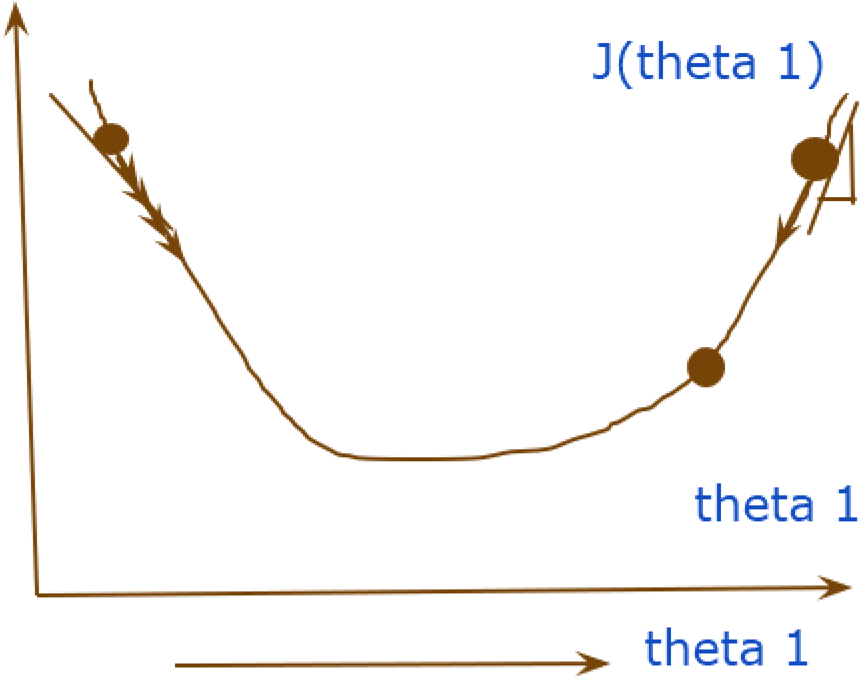

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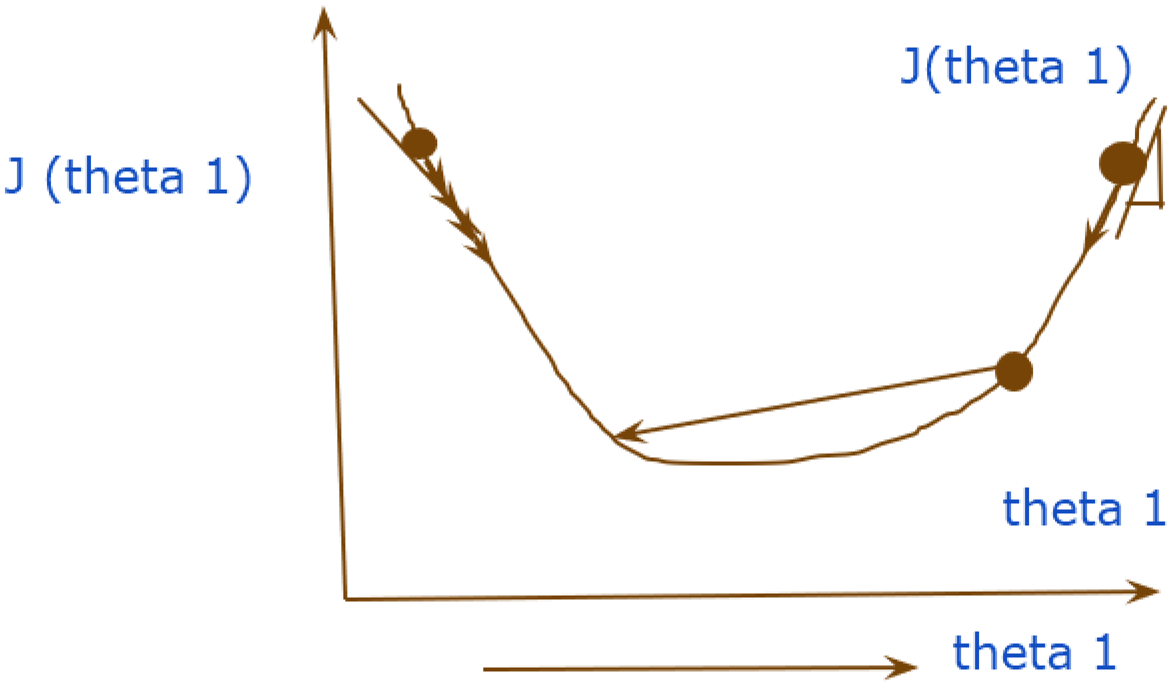

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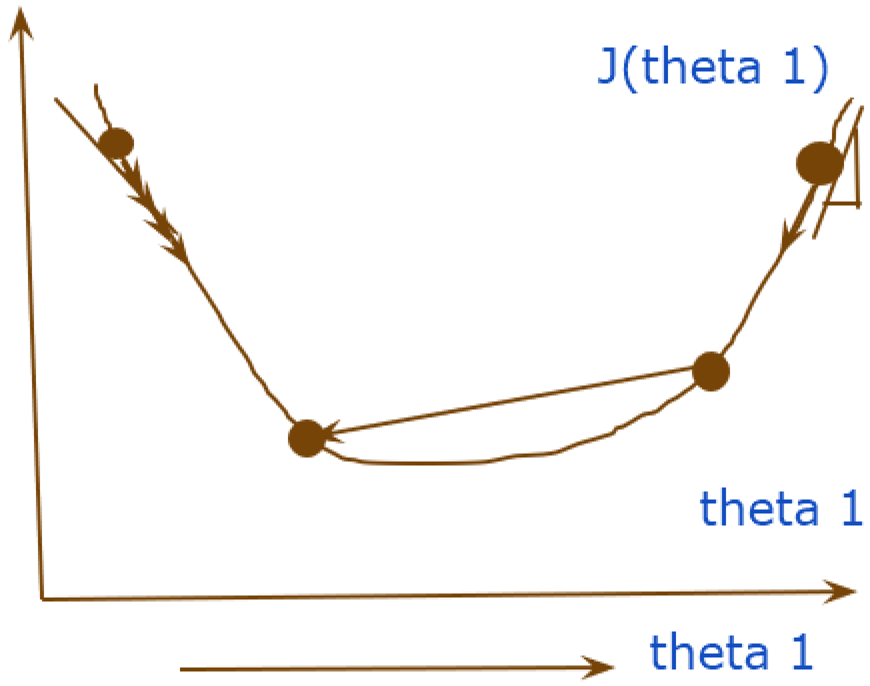

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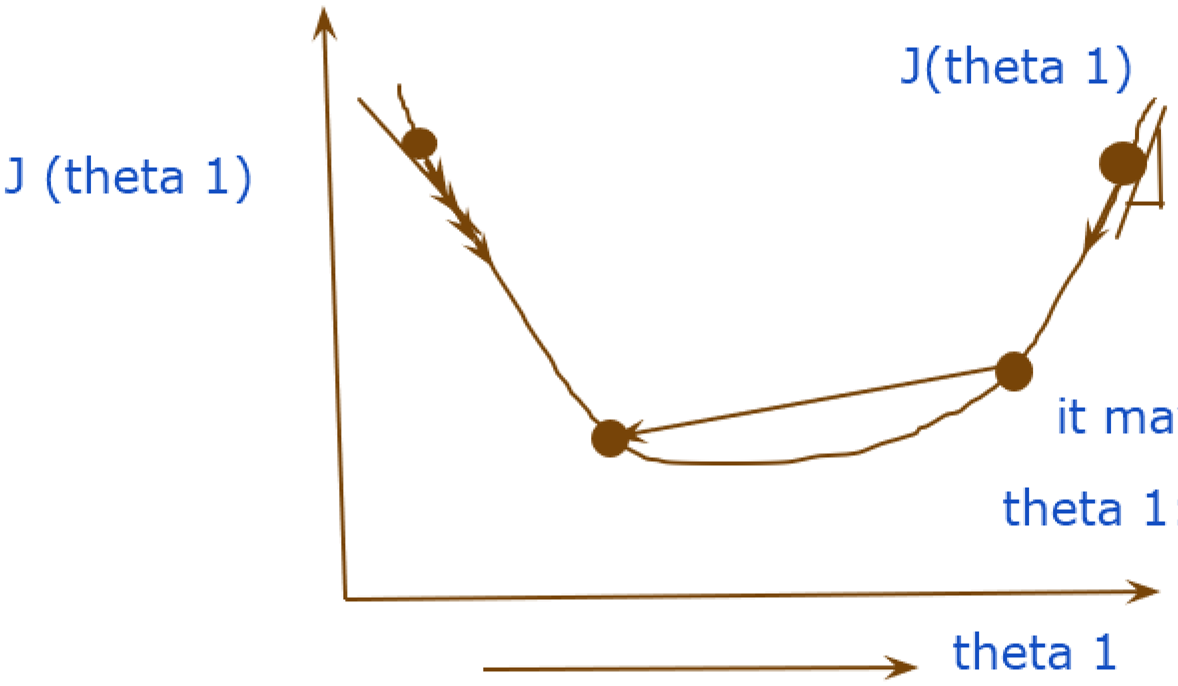

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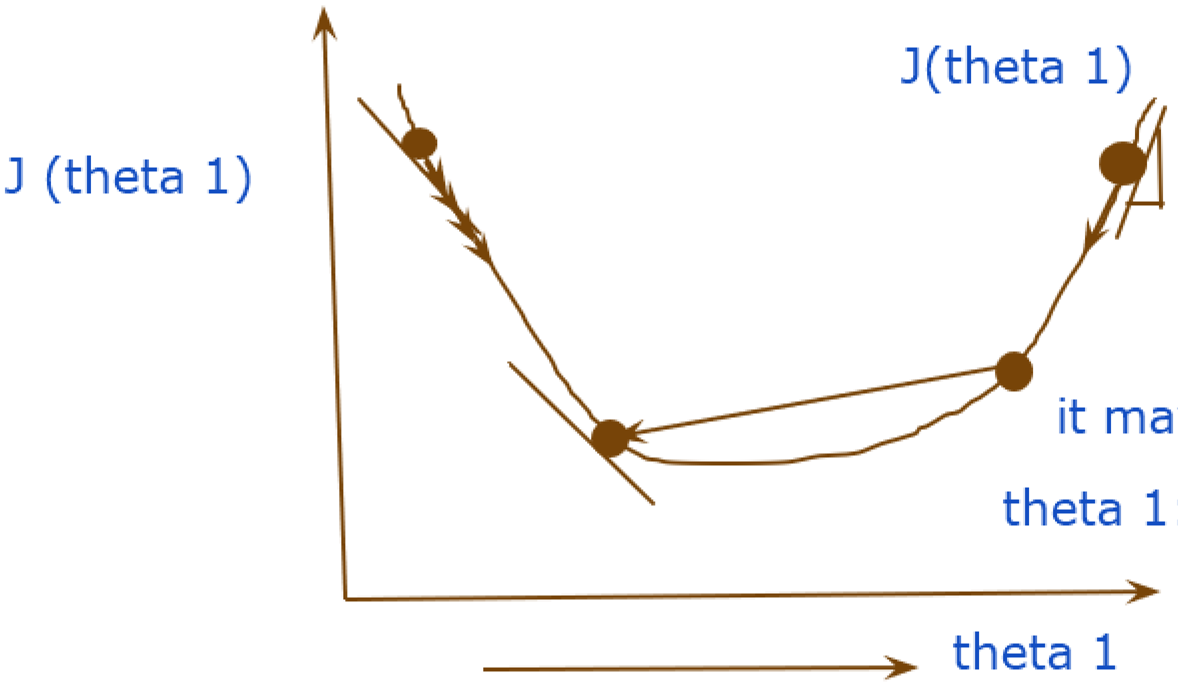

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Gradient Descent Algorithm

Have some function $J(\theta_0, \theta_1)$

Want $\min_{\theta_0, \theta_1} J(\theta_0, \theta_1)$ This is true for all θ_i
For i = 0, 1, 2, 3, …., n

Steps:

- Start with some θ_0, θ_1
- Keep changing θ_0, θ_1 to reduce $J(\theta_0, \theta_1)$

  until we hopefully end up at a minimum

Gradient descent algorithm

$$\text{repeat until convergence } \{$$
$$\theta_j := \theta_j - \alpha \frac{\partial}{\partial \theta_j} J(\theta_0, \theta_1) \qquad (\text{for } j = 0 \text{ and } j = 1)$$
$$\}$$

Learning Rate

Correct Update:

$$\left.\begin{aligned}
\text{temp0} &:= \theta_0 - \alpha \tfrac{\partial}{\partial \theta_0} J(\theta_0, \theta_1) \\
\text{temp1} &:= \theta_1 - \alpha \tfrac{\partial}{\partial \theta_1} J(\theta_0, \theta_1) \\
\theta_0 &:= \text{temp0} \\
\theta_1 &:= \text{temp1}
\end{aligned}\right\}$$

update

Simultaneously: θ_0 and θ_1

Gradient descent can converge to a local minimum, even with fixed (α) learning rate.

$$\theta_1 := \theta_1 - \alpha \frac{d}{d\theta_1} J(\theta_1)$$

As we approach a local minimum, gradient descent will automatically take smaller steps. So, no need to decrease α over time.

"Batch" gradient Descent algorithm:
"Stochastic" gradient descent algorithm

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Each step of gradient descent uses all the training example: batch gradient descent algorithm
Each step of gradient decent uses single training example
Mini-batch: each step of gradient descent uses subset of training example

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“Batch” Gradient Descent

“Batch”: Each step of gradient descent uses all the training examples.

“Stochastic” Gradient Descent

“Stochastic”: Each step of gradient descent use only single training example.

“Mini-batch” Gradient Descent

It lies in between of these two extremes, and can use a mini-batch (small portion) of training data examples in each step

Batch Gradient Descent Algorithm

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J (theta 1): = 1/2m summation (i = 1 to m) [h(x)i -(y)i]

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Training data points

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Training data points

Vanilla gradient descent algorithm/gradient descent algorithm

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update the parameters for each training example one by one

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Mini-batch gradient descent algorithm

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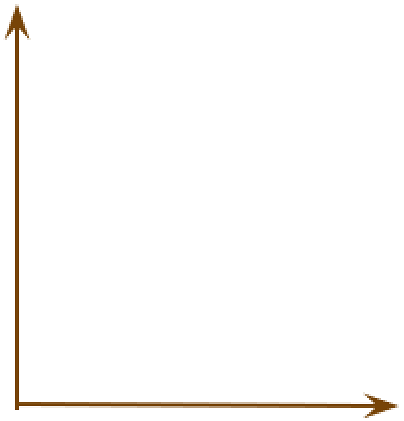

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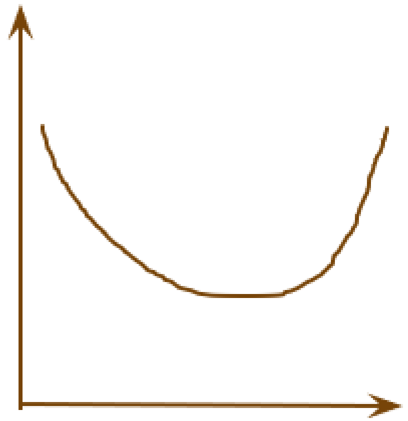

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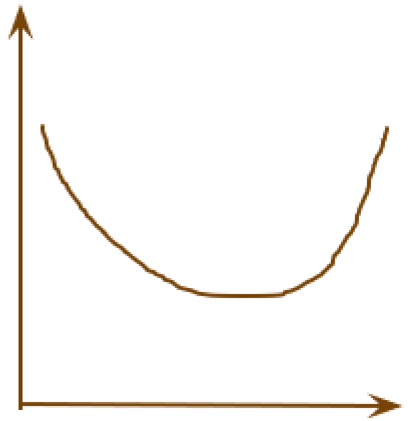

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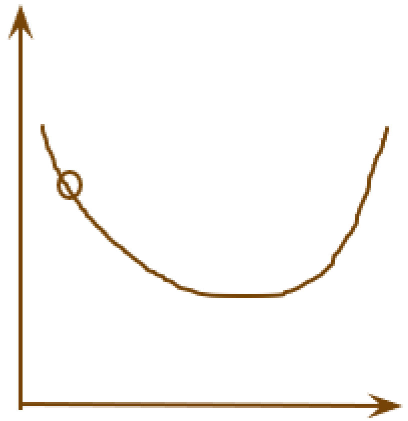

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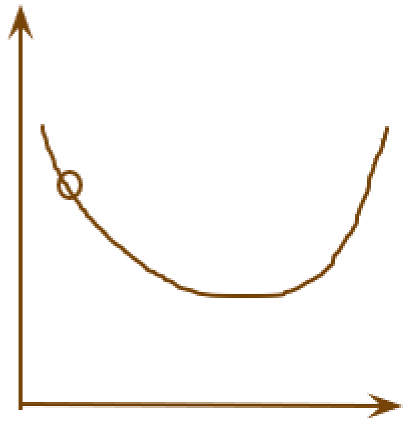

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