Gradient Descent

Week 05 - Day 03

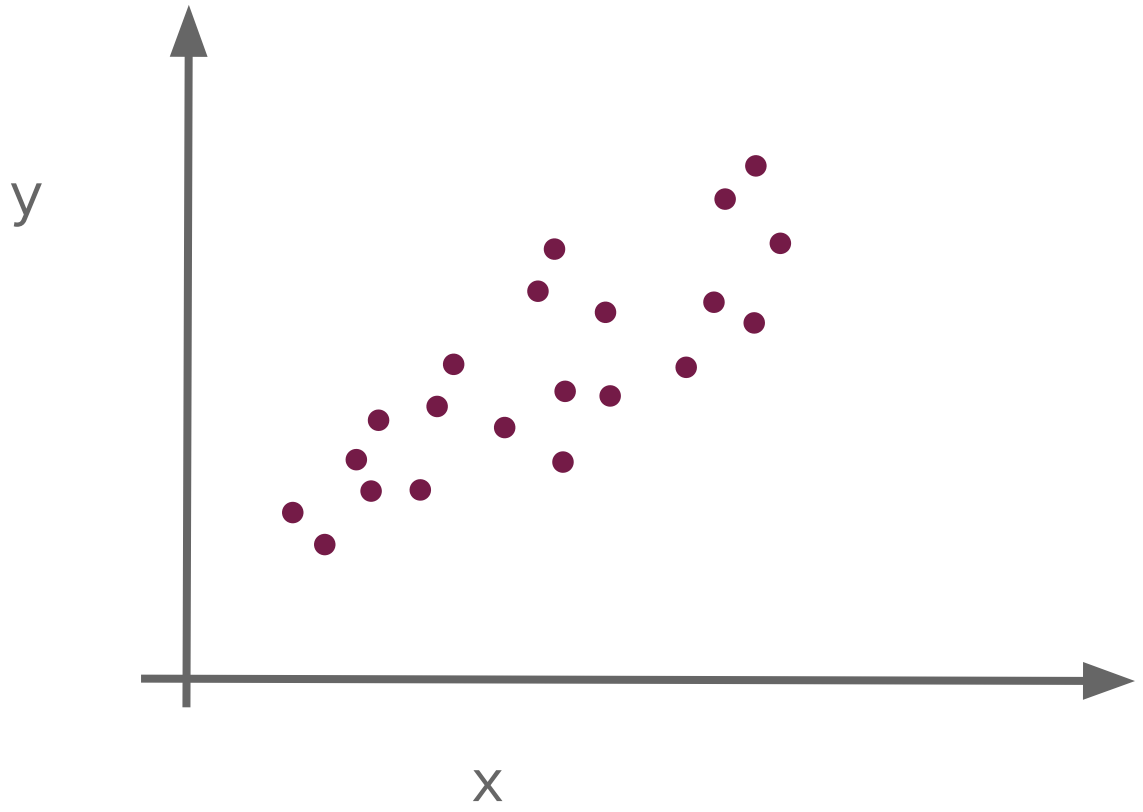
A general algorithm to optimize a loss function in ML

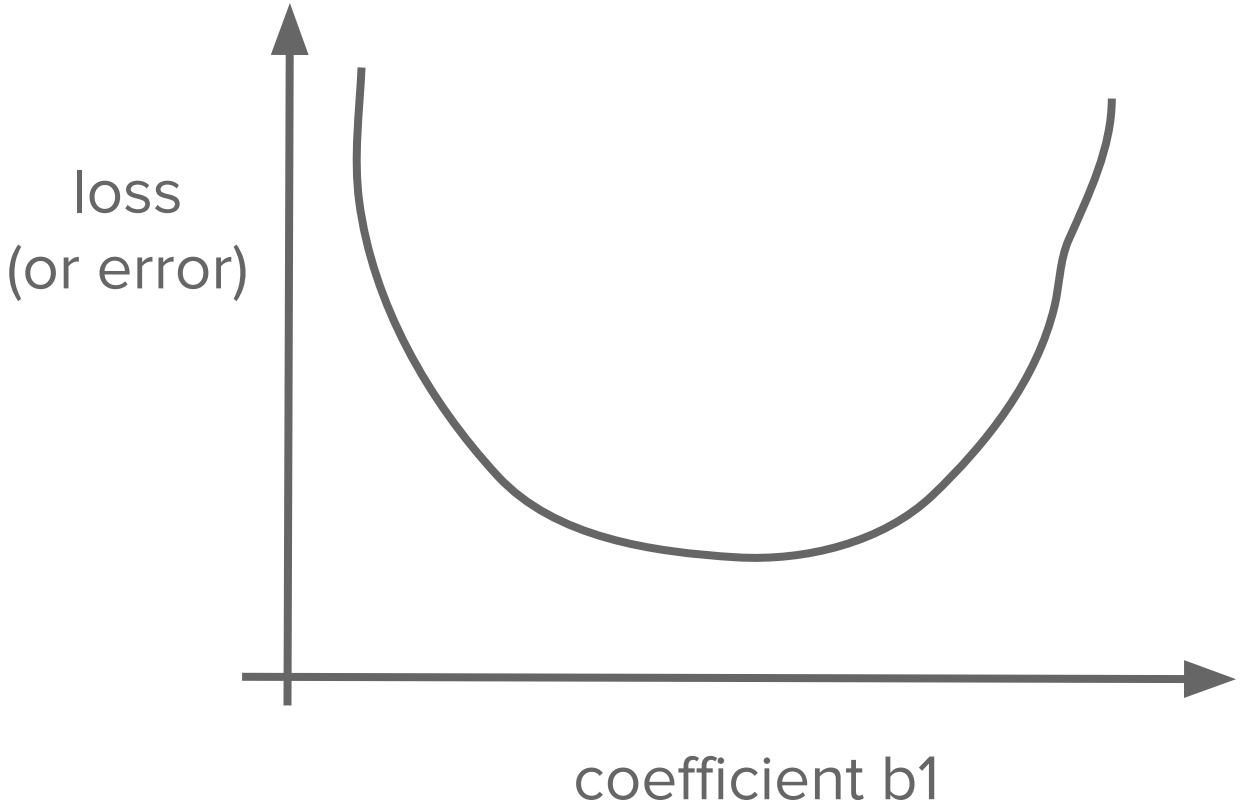
You’ll never manually use it but...

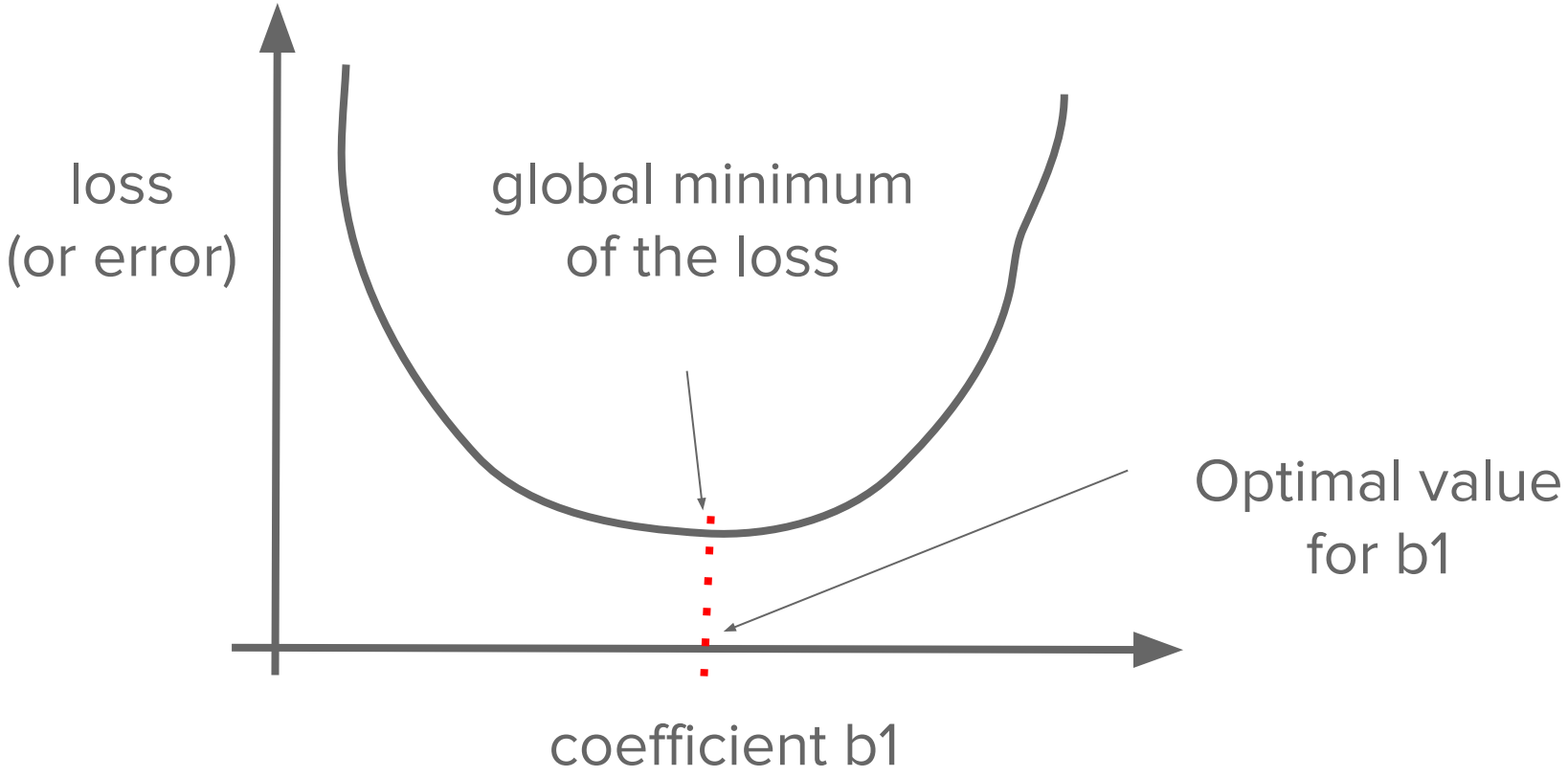
It’s a common interview question!

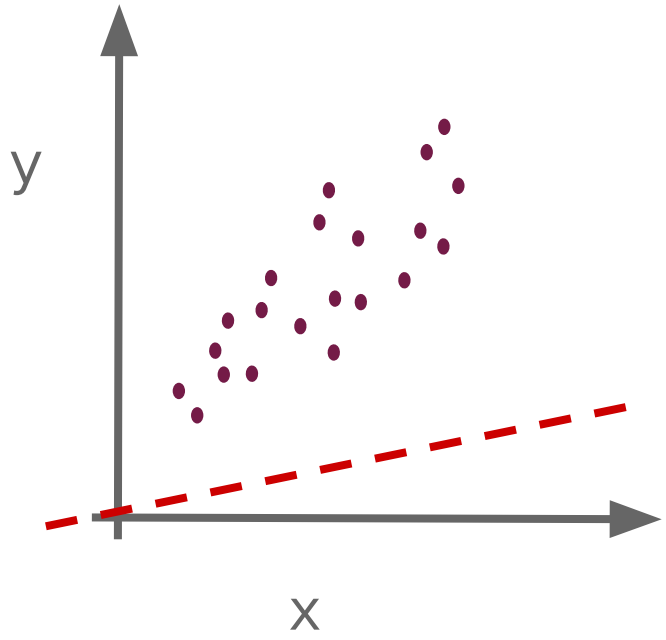
Optimizing the loss function

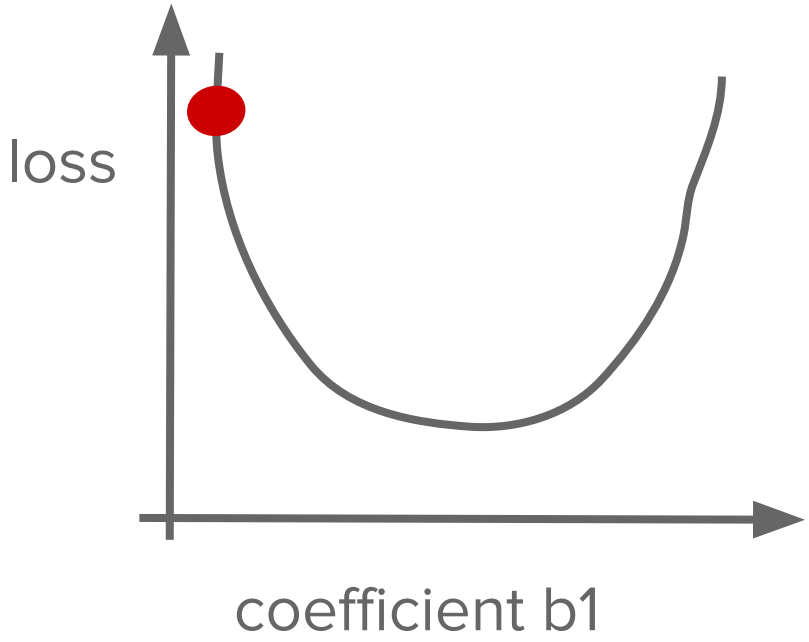
Linear regression: y = b1*x + e

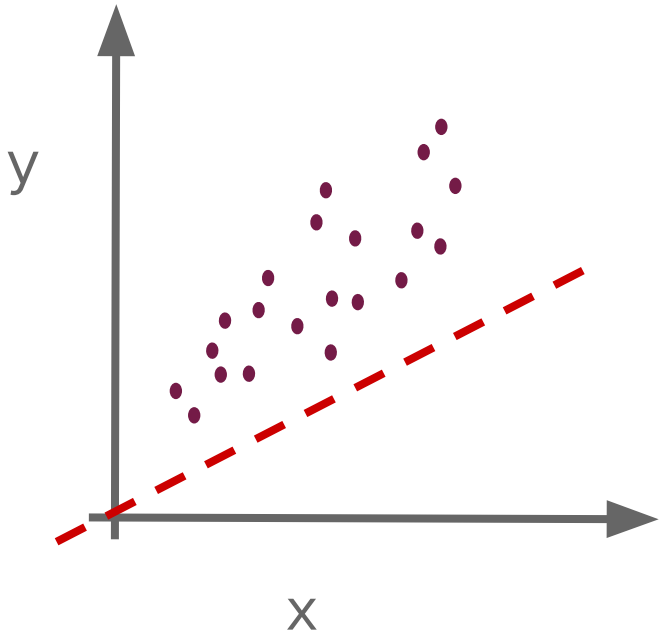



loss
(or error)
coefficient b1


loss
(or error)
global minimum
of the loss
Optimal value
for b1
coefficient b1


y
x


loss
coefficient b1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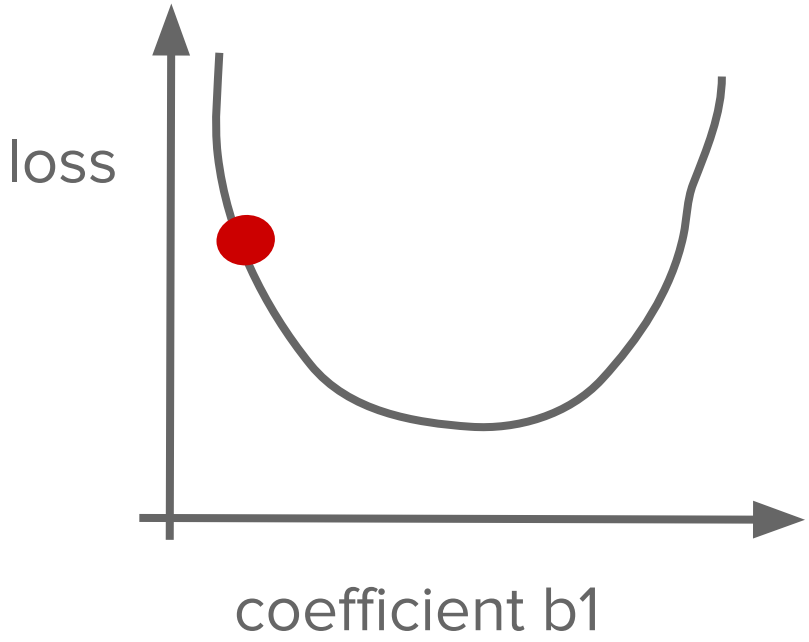
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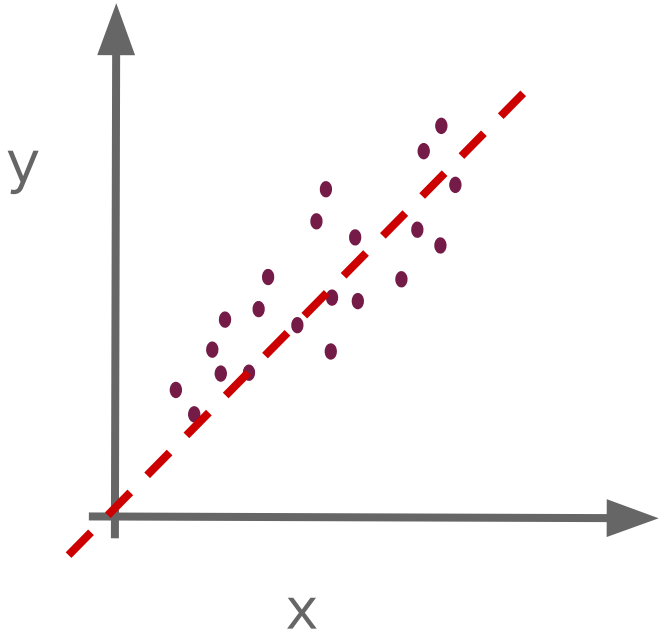
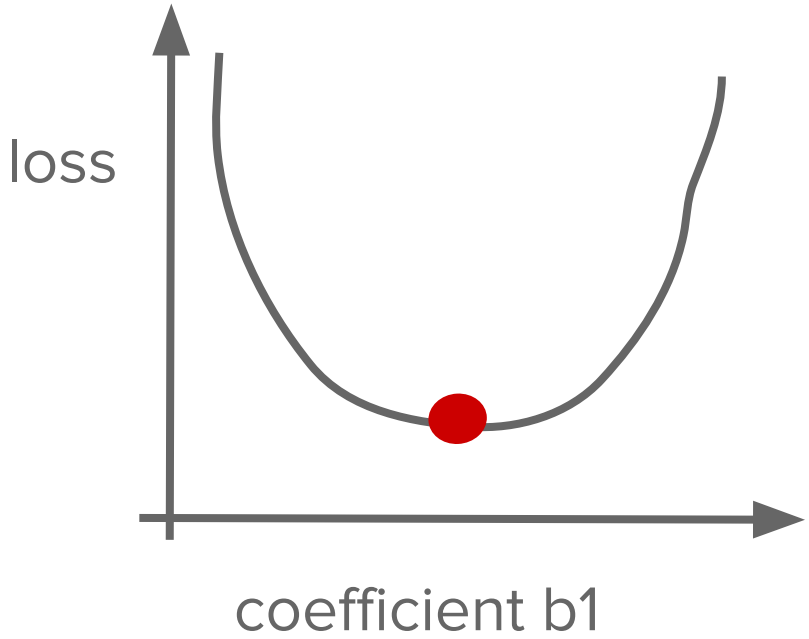

y
x


loss
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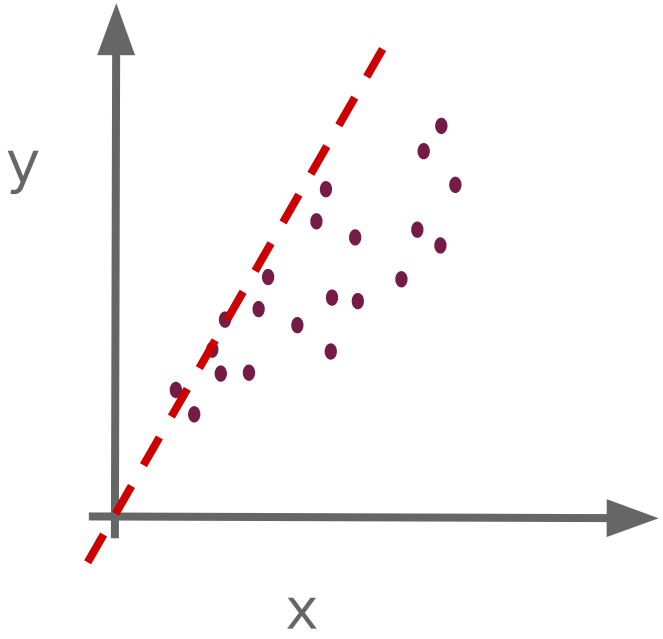
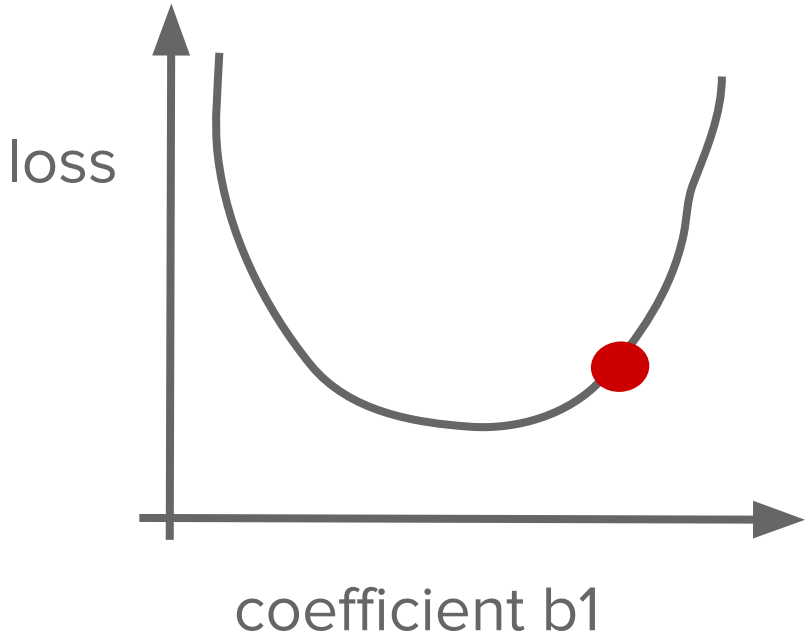

y
x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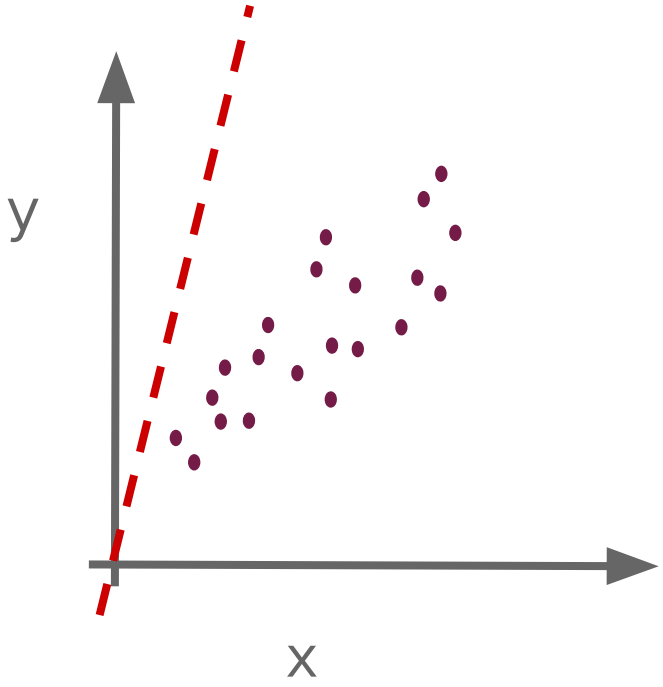
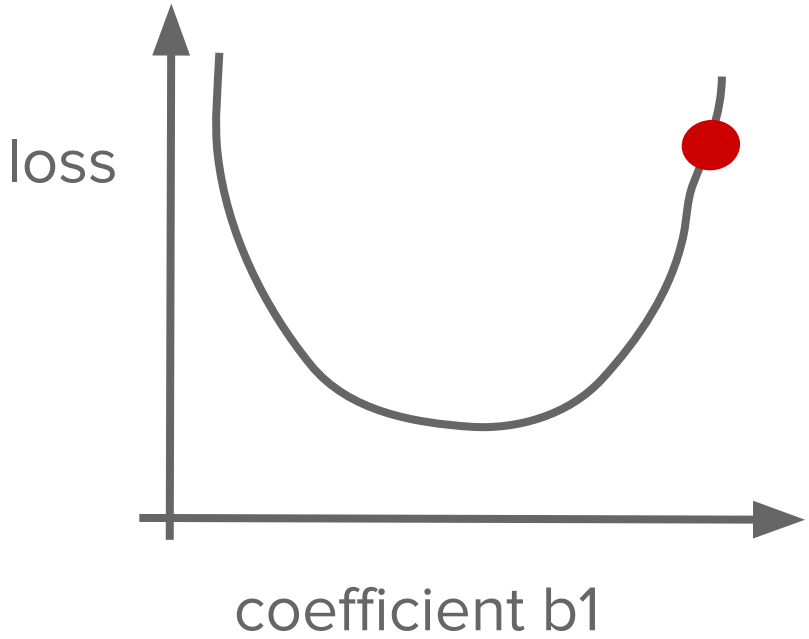

y
x


loss
coefficient b1

We used calculus to find the best point

derivative(loss_function)=0

Gradient Descent

A general optimization algorithm to find the best parameters

(i.e. the smallest error)

Iterative approach

1) Start with random solution (b0,b1)

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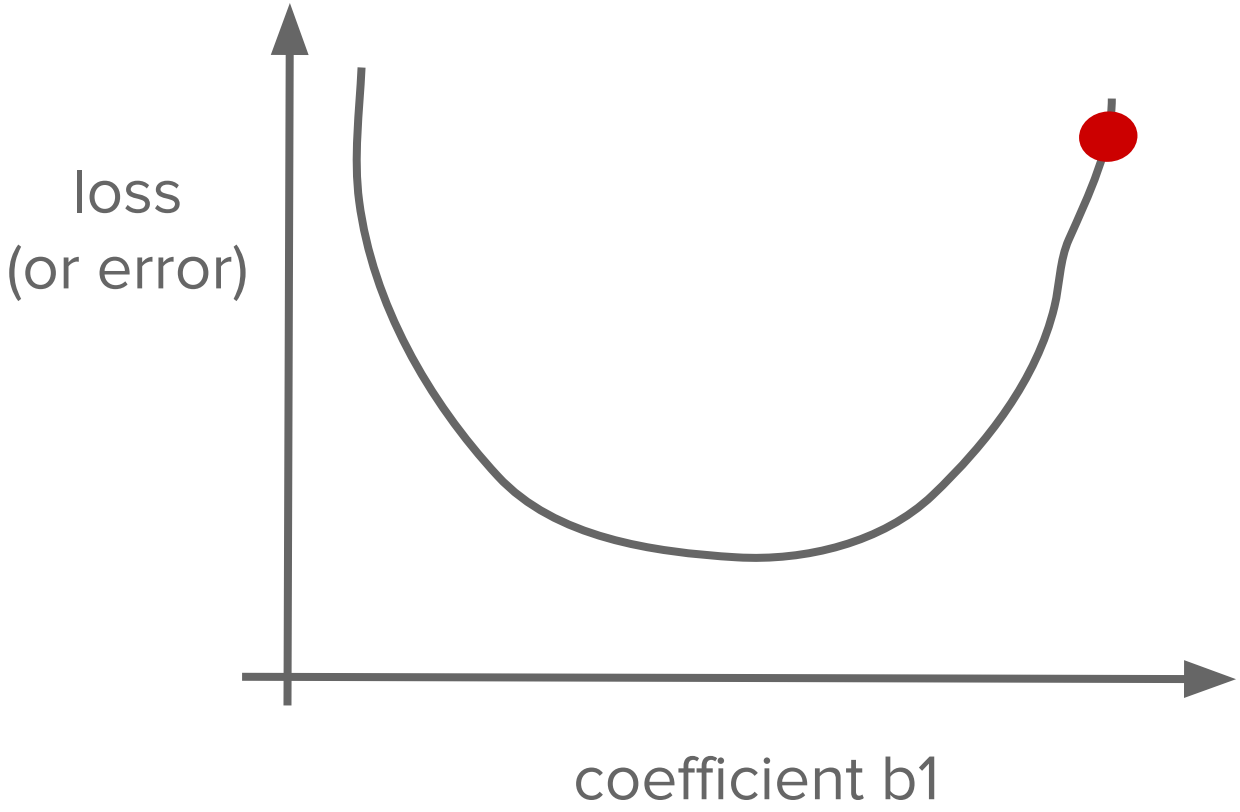
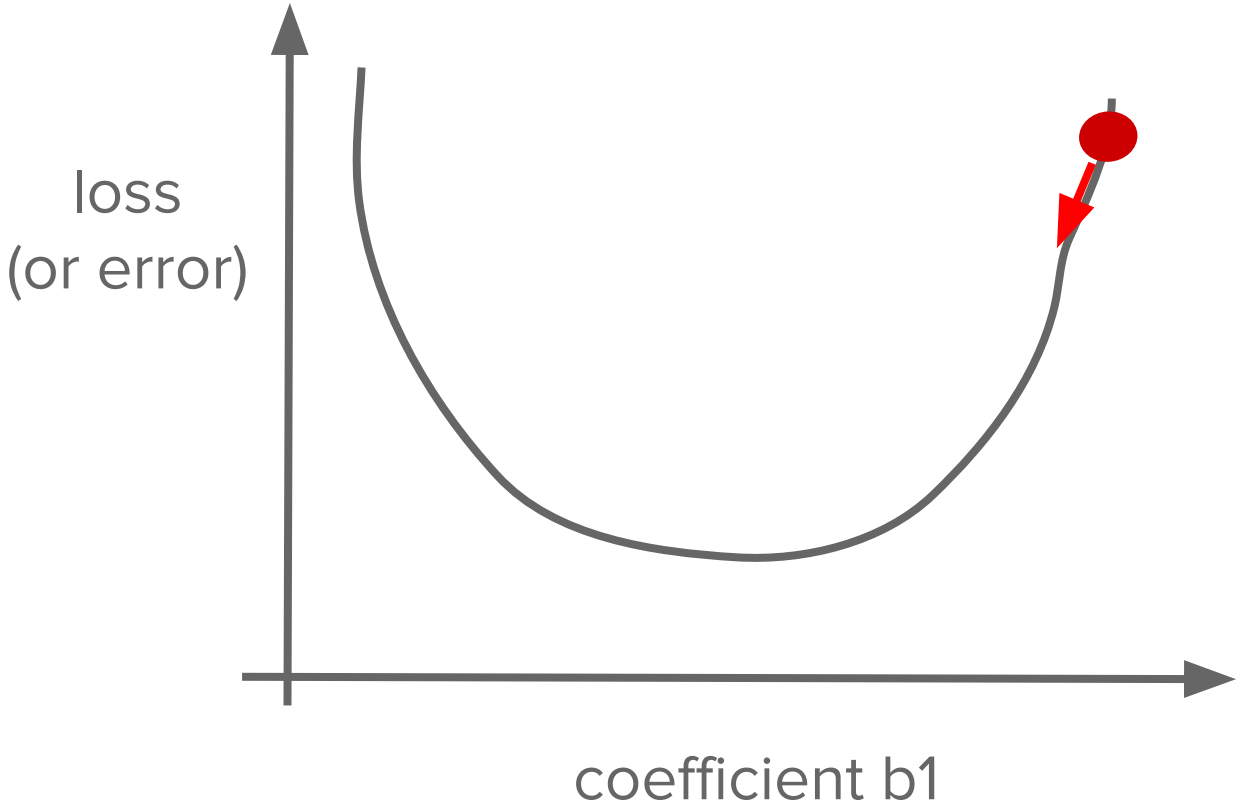
4) Repeat steps 2 and 3


loss
(or error)
coefficient b1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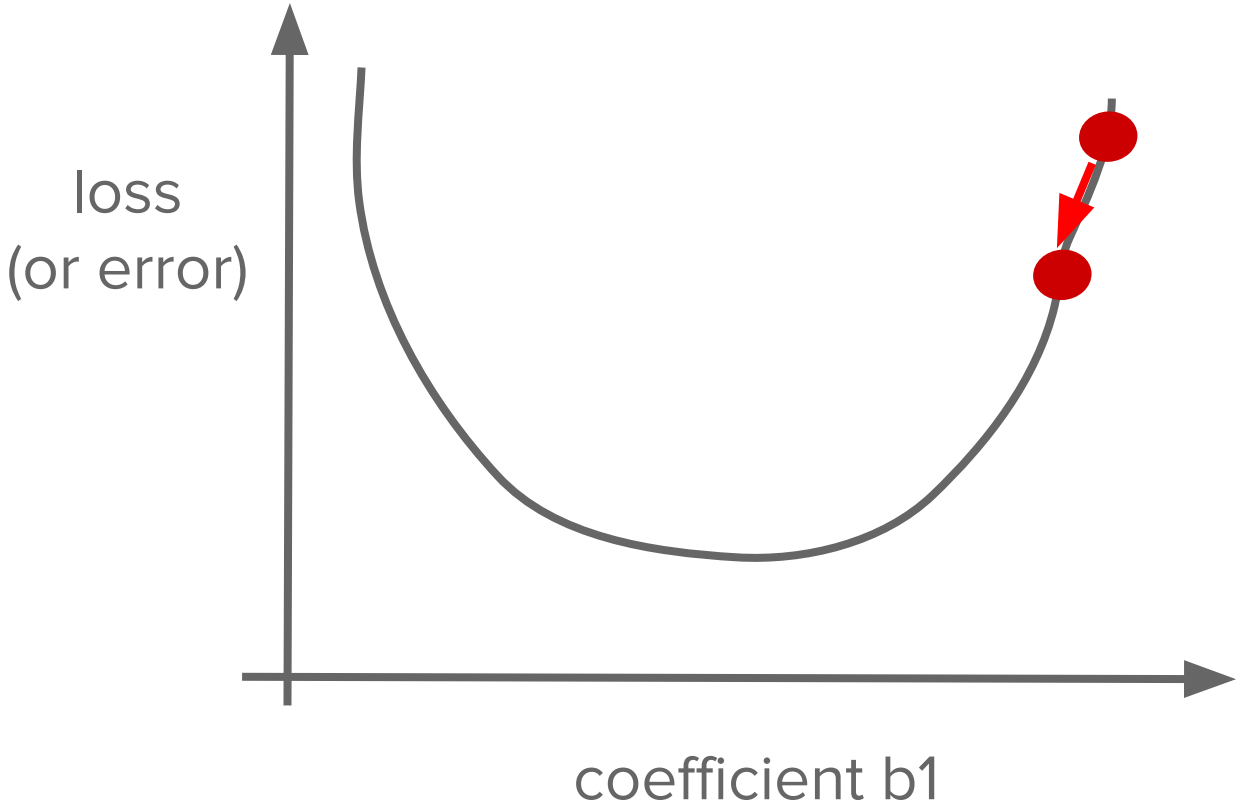
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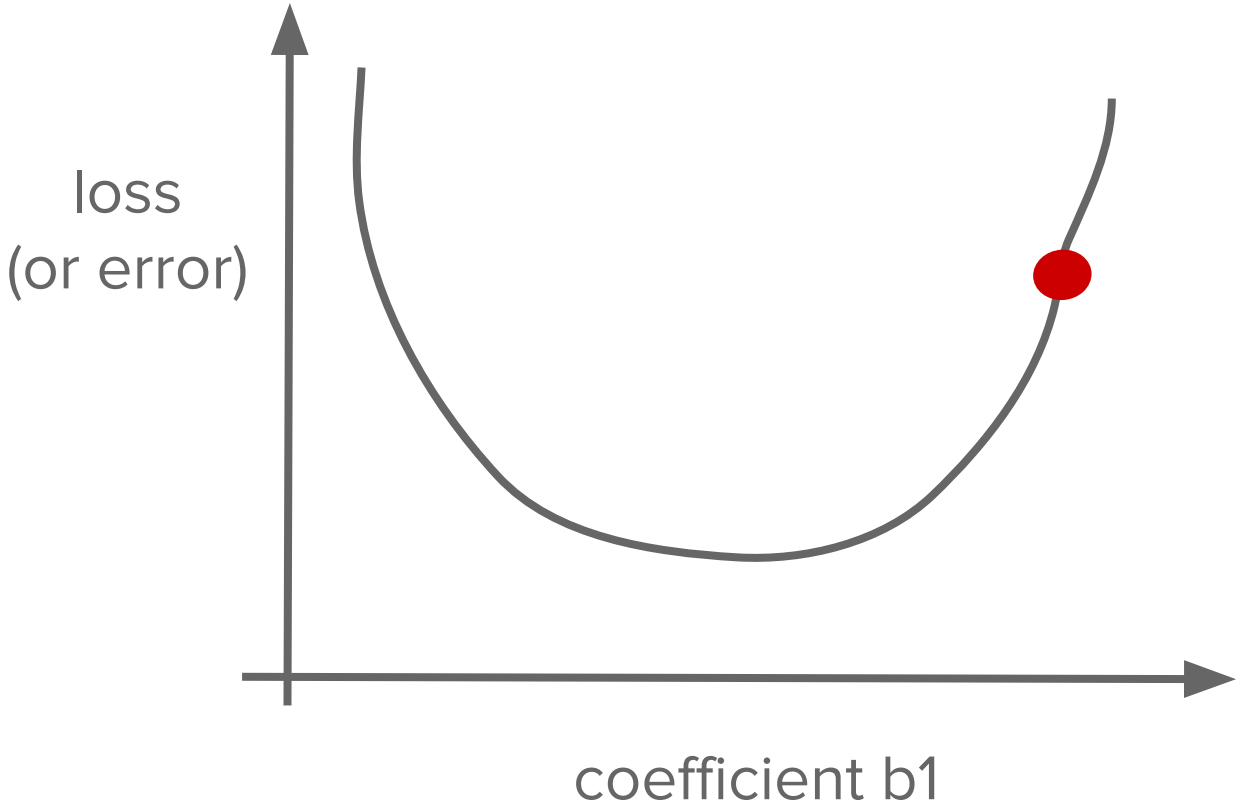
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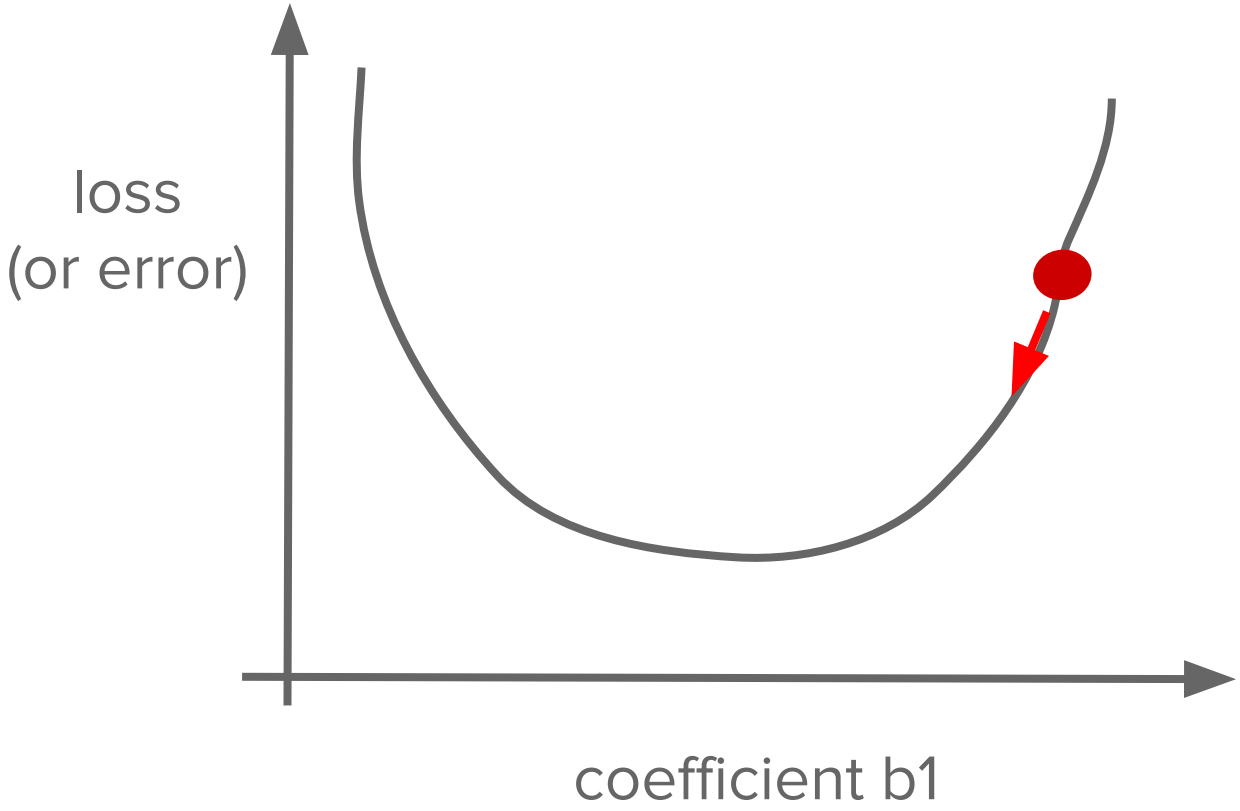
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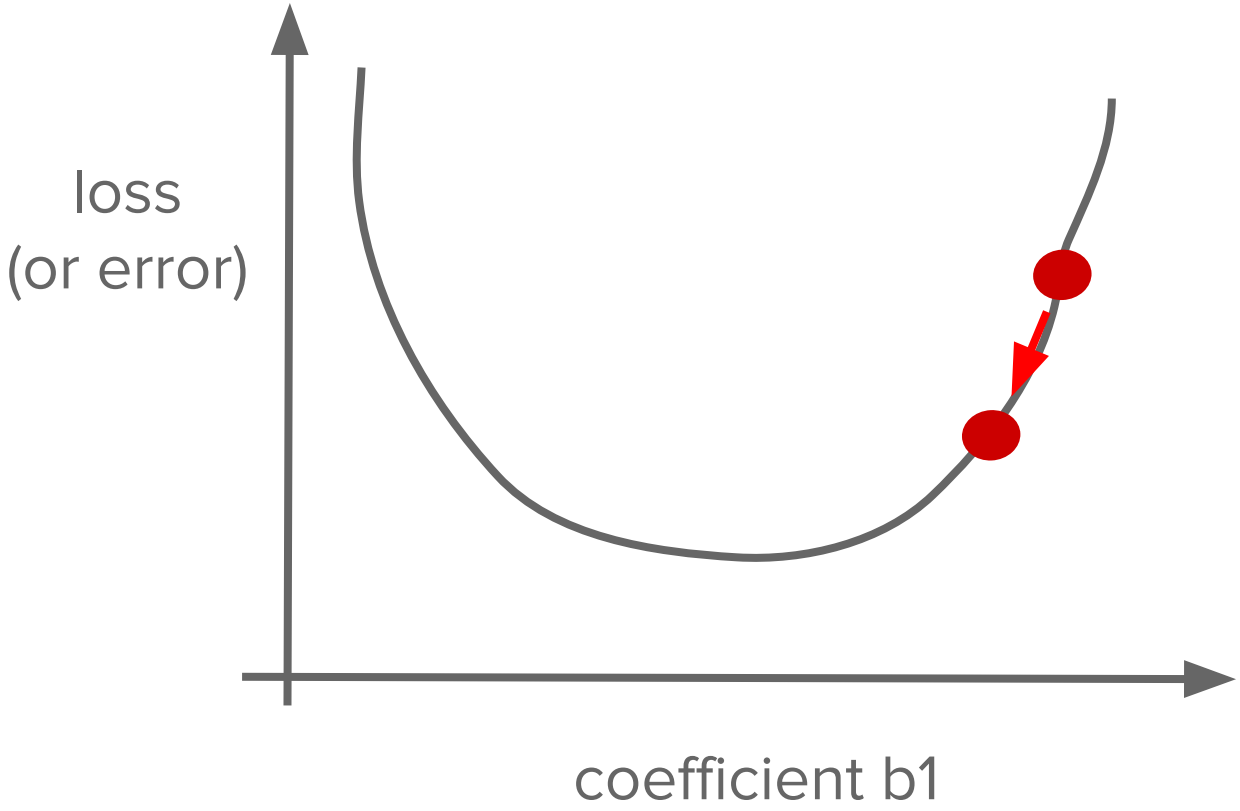
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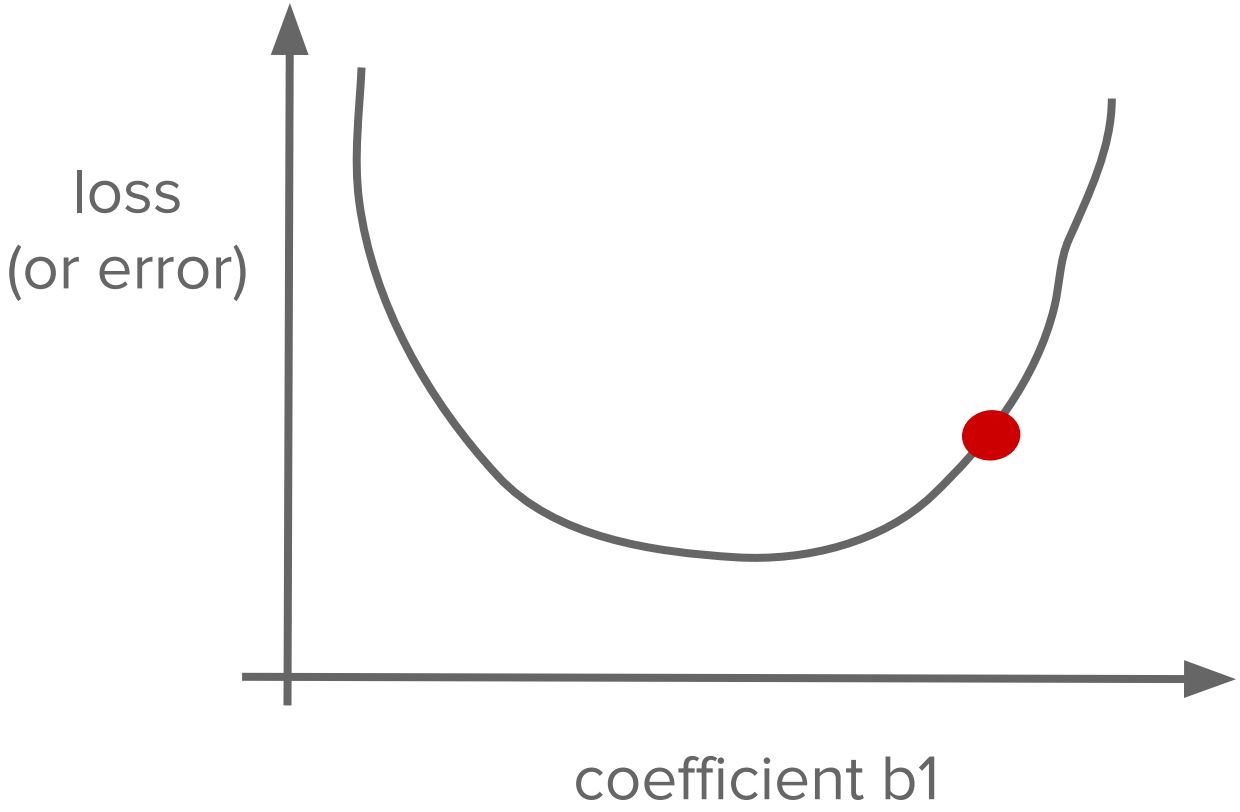
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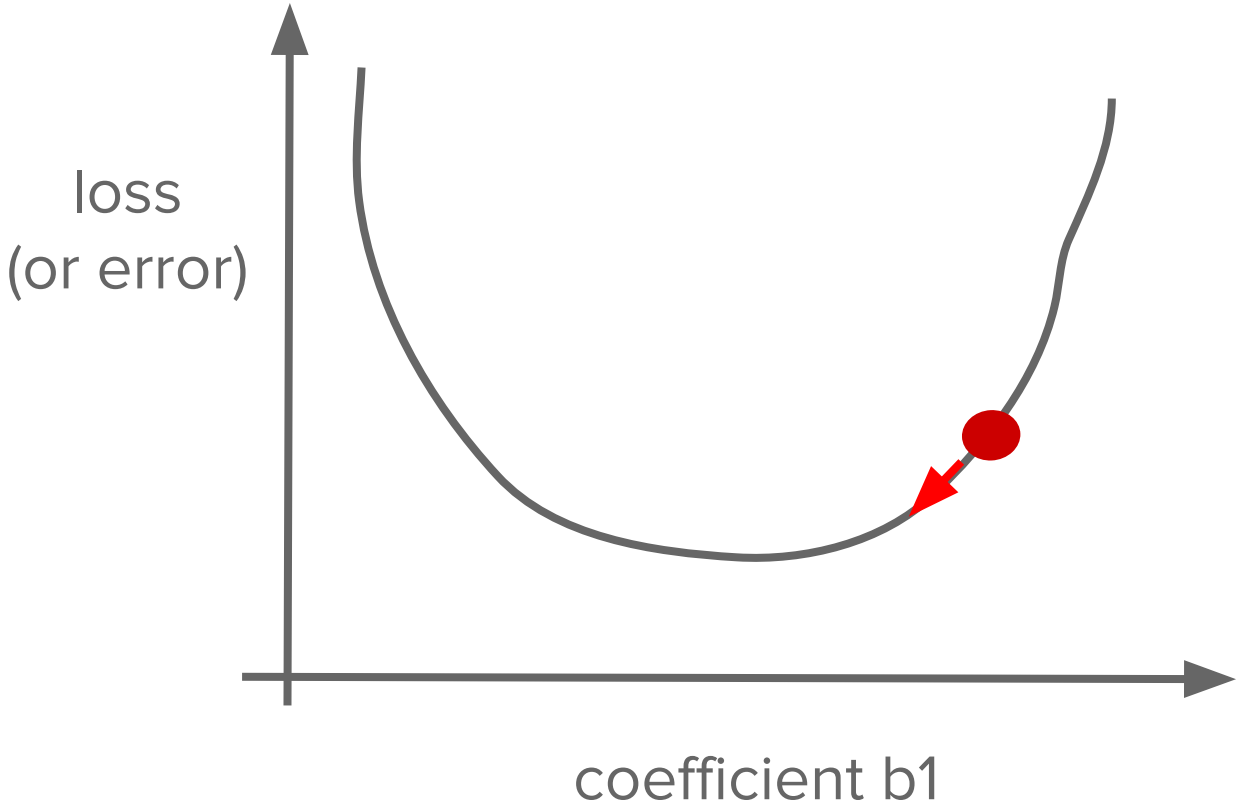
loss
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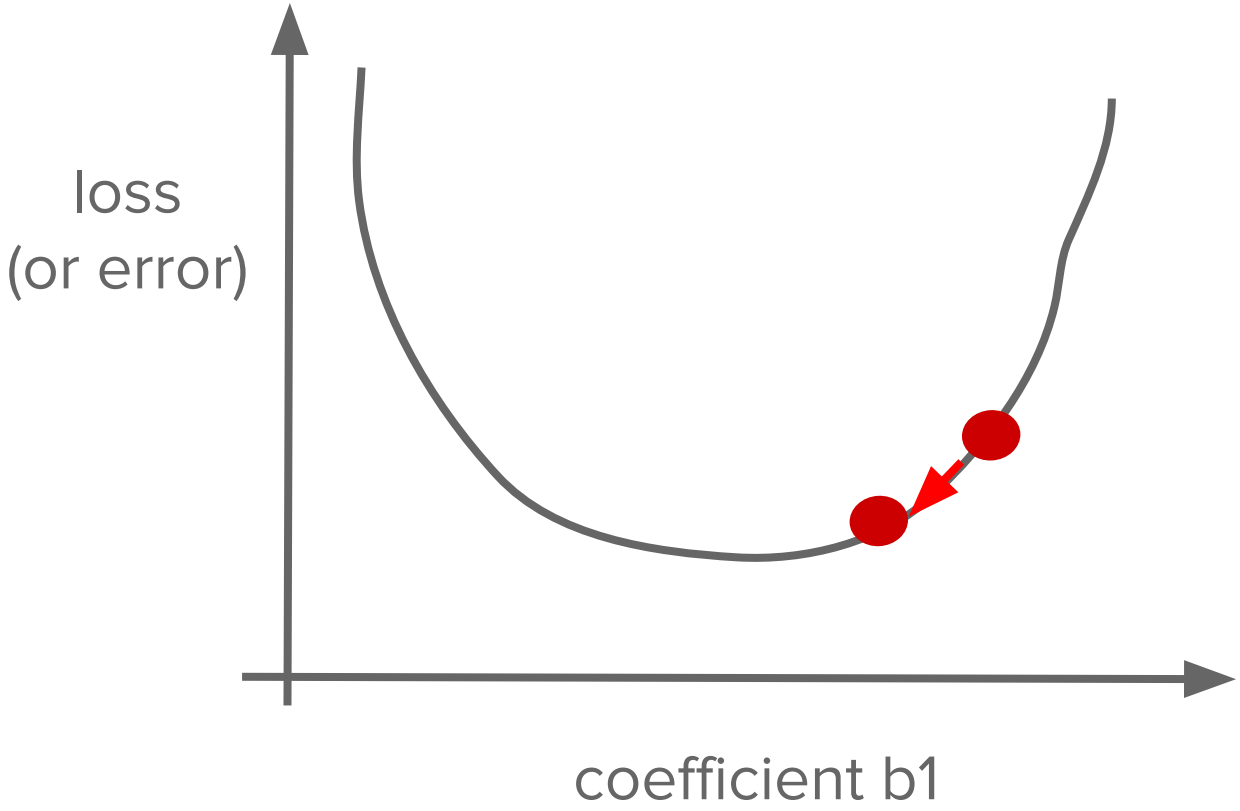
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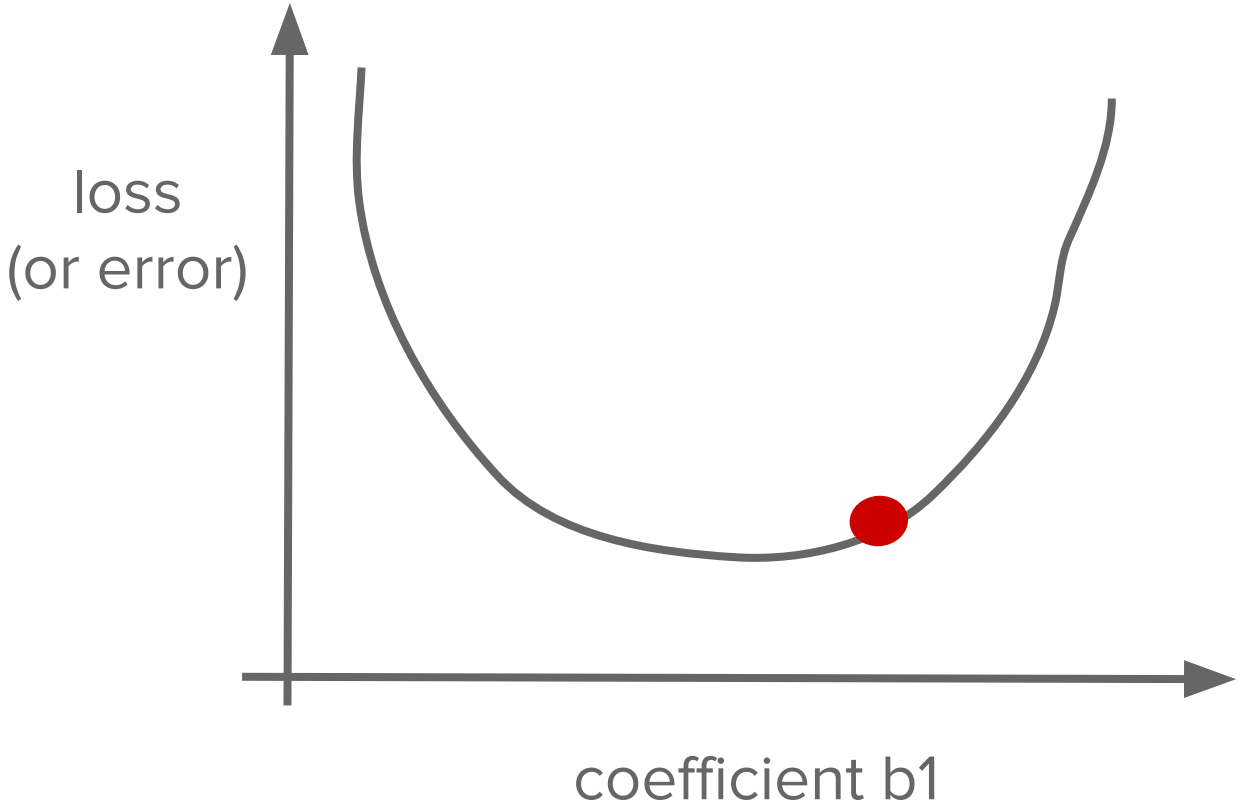
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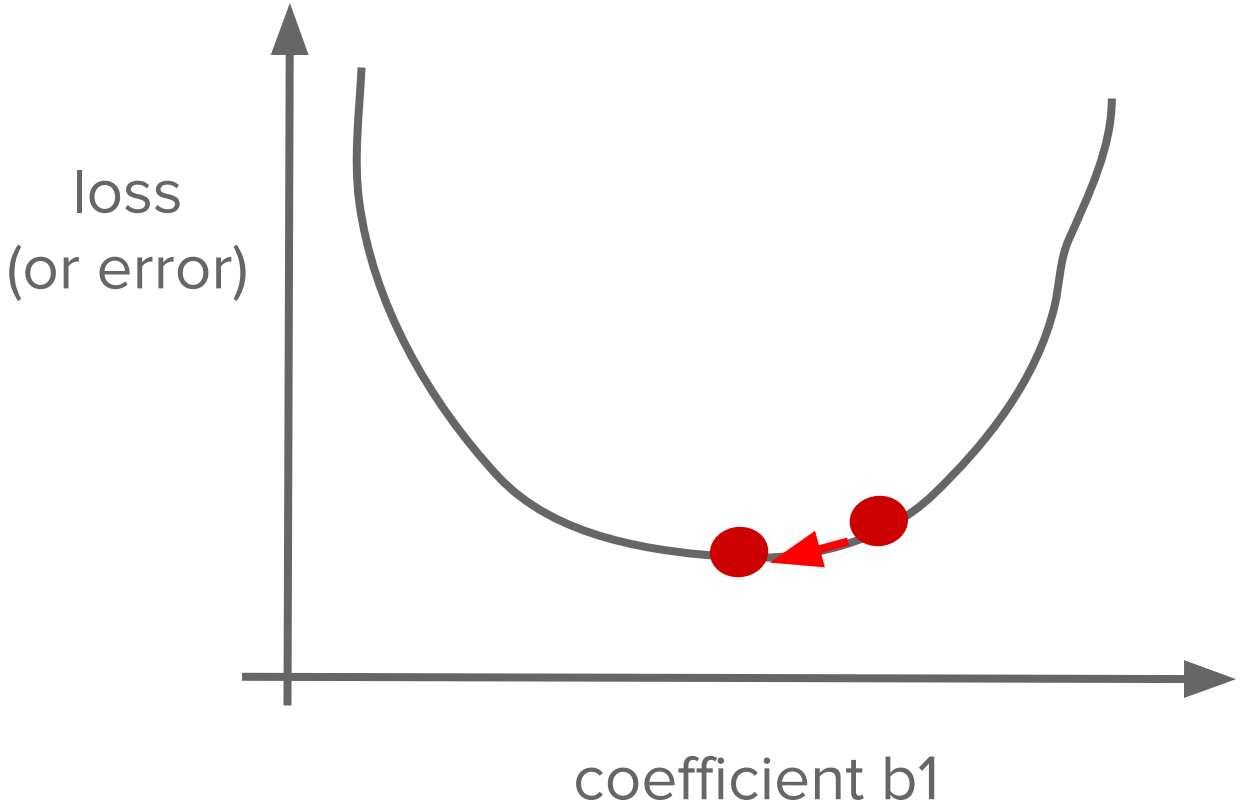
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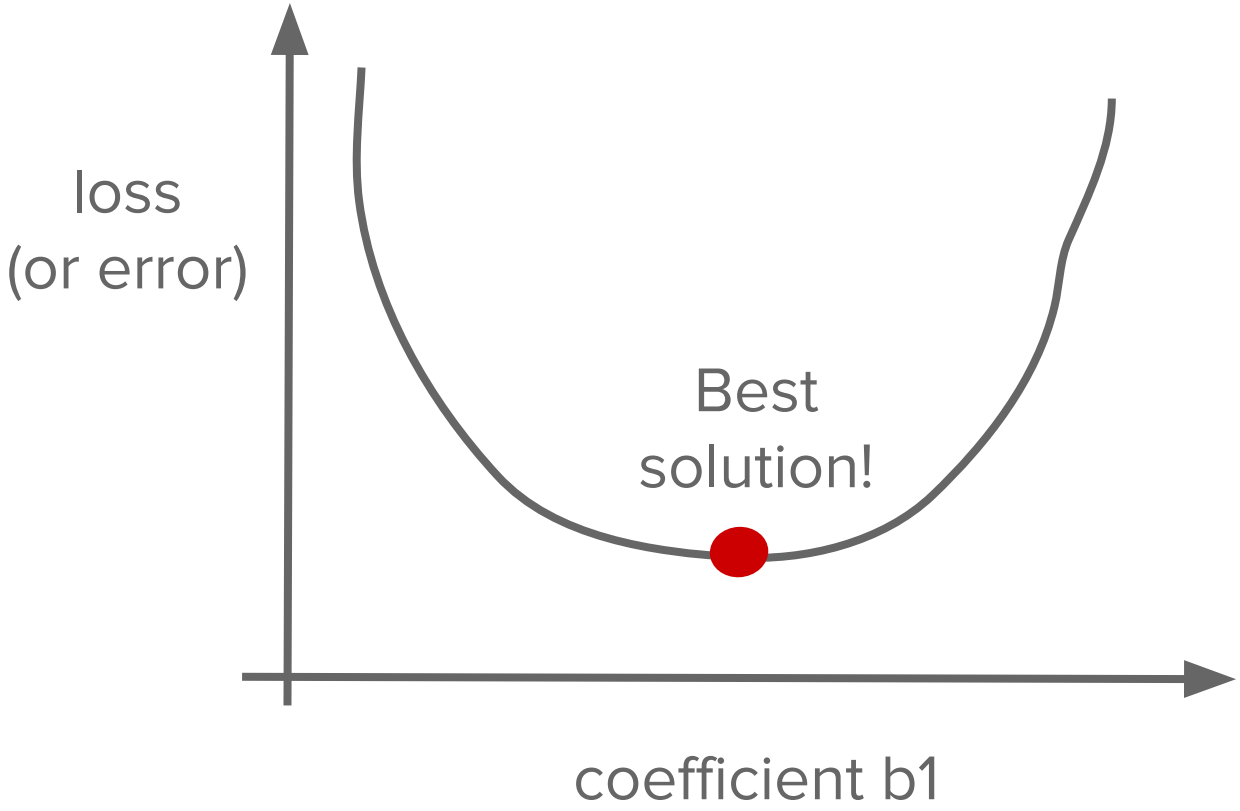
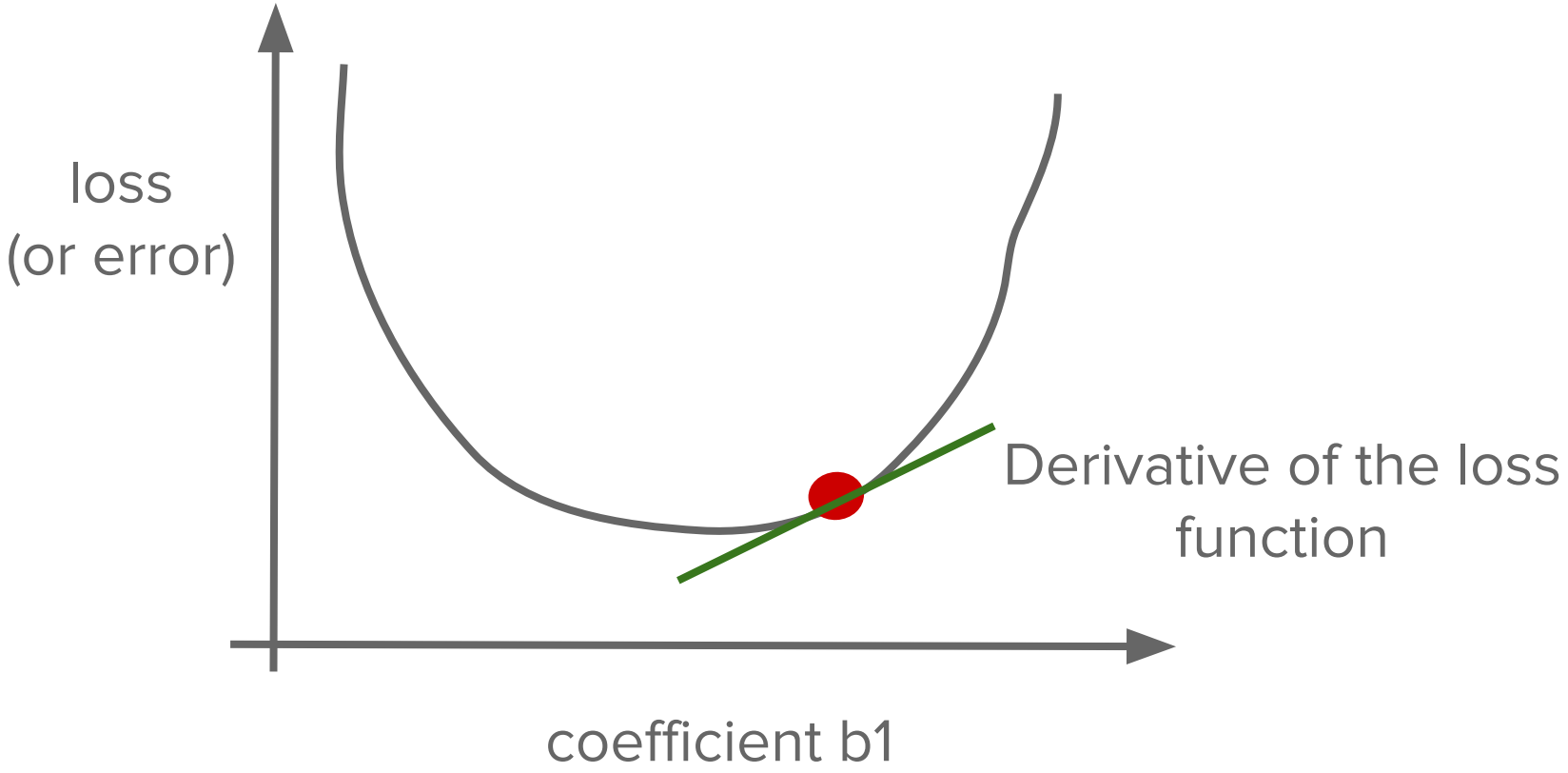

loss
(or error)
Best
solution!
coefficient b1

How do we find the best right direction?


loss
(or error)
Derivative of the loss
function
coefficient b1

$$prediction = b0 + b1*x1$$

$$error = (y - prediction)**2$$

$$error = (y - (b0 + b1*x1))**2$$

$$partial\_derivative(error,b0,b1) = (7,5)$$

$$b0 = b0 - 7$$

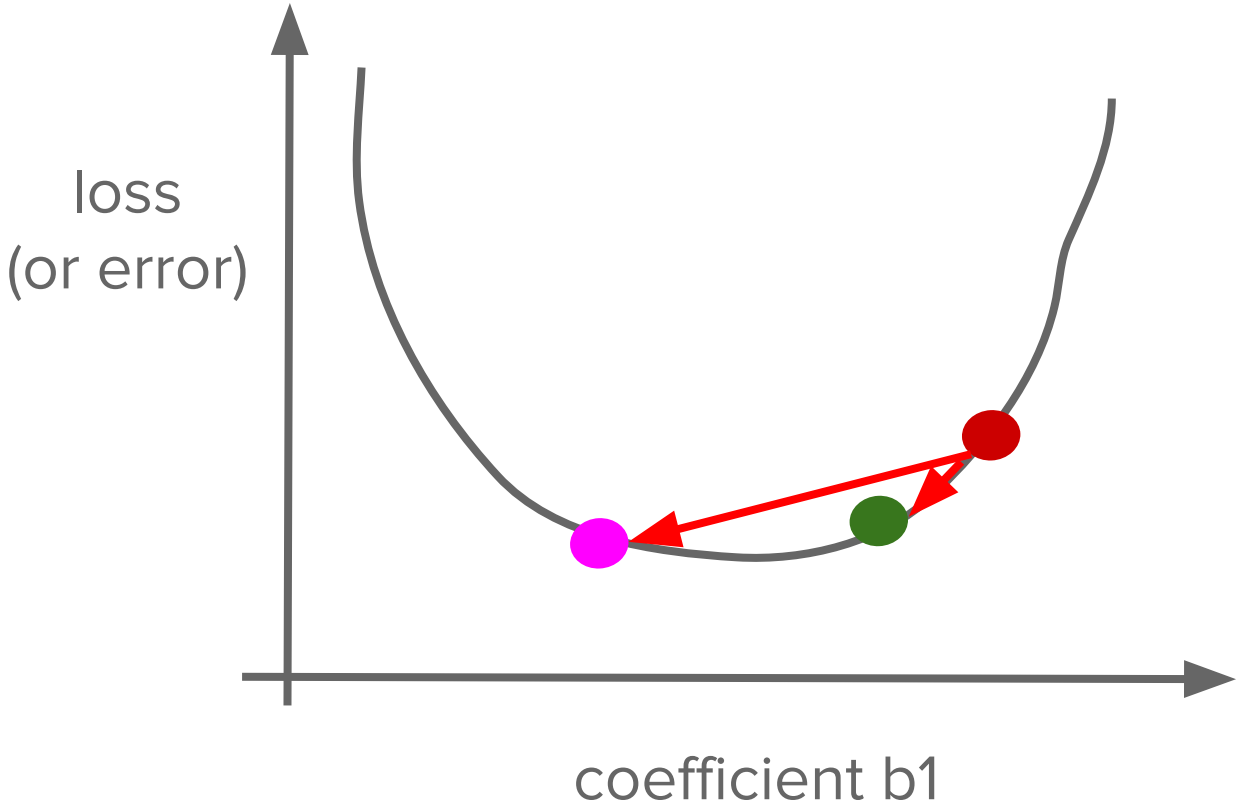
$$b1 = b1 - 5$$

$$b0 = b0 - \mathbf{0.01} * 7$$

$$b1 = b1 - \mathbf{0.01} * 5$$

Size of the step

Learning rate


loss
(or error)
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Small learning rate

++ faster

-- may no convergence

Small learning rate

-- slower

++ convergence

Recap

1. gradient descent = optimization process

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2. iterative approach

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3. small updates of the coefficients

1. gradient descent = optimization process
2. iterative approach
3. small updates of the coefficients
4. direction = derivative

1. gradient descent = optimization process
2. iterative approach
3. small updates of the coefficients
4. direction = derivative
5. learning rate is important

1. Andrew Ng - gradient descent
2. Siraj - gradient descent
3. Derivatives
4. Partial Derivatives