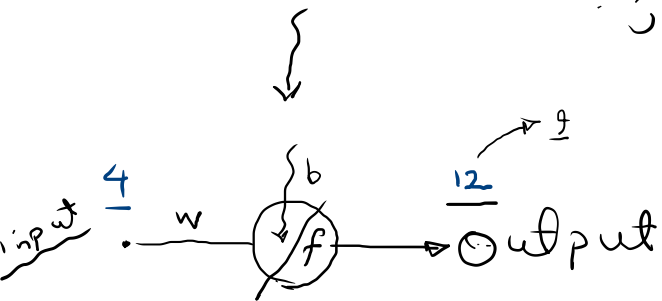


Optimization

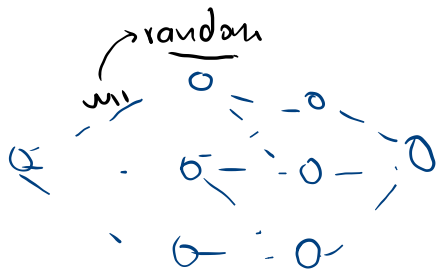
Process!

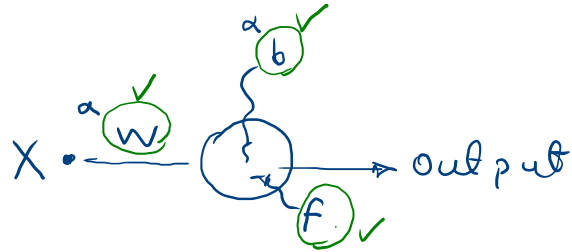


؟ opt.

Dataset

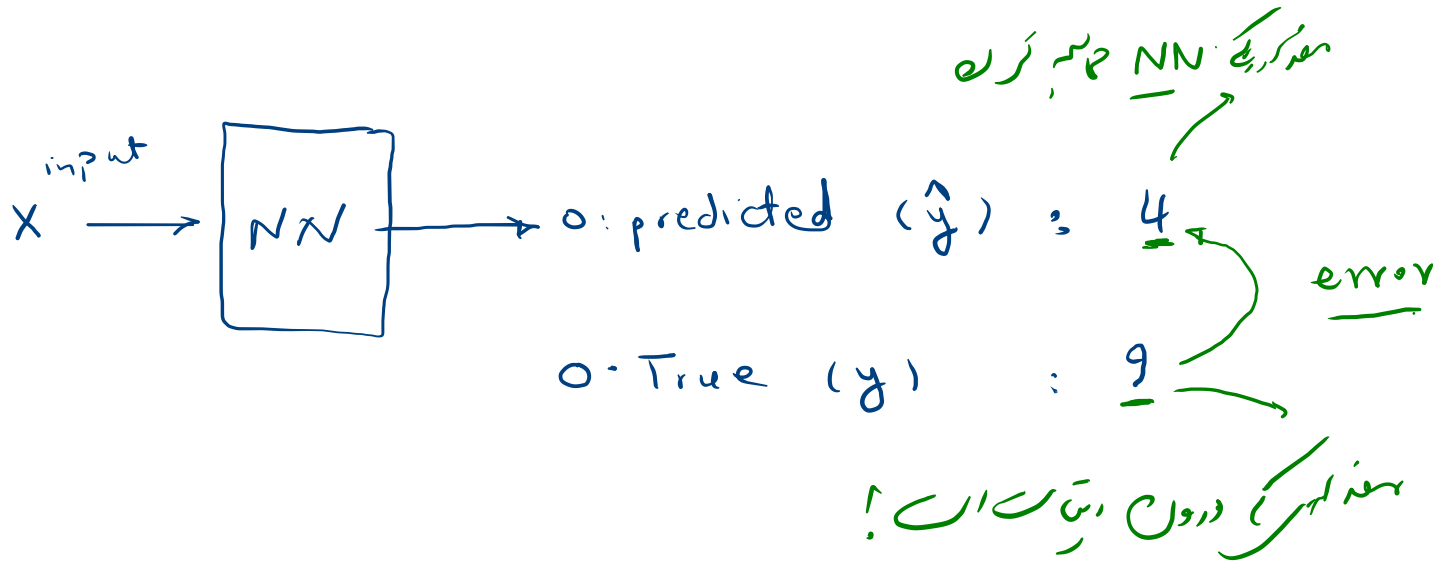
	area	Price
1	4	9
2	5	11
	⋮	⋮





optimization ← تغیر وزن کے ذریعے سیکھ کر حتمی سسٹم سے (predicted)

با حتمی نتائج (True)  
actual



error  $\rightarrow$   $\hat{y} - y_{true}$   $\leadsto$  { Example : error : 10  
sample : error : -10

error = ave (err<sub>i</sub>)  $\leadsto$  err =  $\frac{10 + (-10)}{2} = 0$

## performance metrics

→ MSE  $\rightarrow$  mean square error  $\Rightarrow$   $MSE = \frac{1}{N} \sum_{i=1}^N (\hat{y}_i - y_i)^2$

MAE

SSE

Cross entropy

⋮

	area	true price	predicted price
→ 4		9	8
→ 5		11	13

$$MSE = \frac{1}{2} \left[ \underset{1}{(8-9)^2} + \underset{4}{(13-11)^2} \right] = \frac{5}{2} = 2.5$$

Loss function  $\alpha$

$$\frac{(y)^t}{8}$$


---


$$13$$


---

$$MSE : \frac{2.5}{x} t^2 \rightarrow$$

$$\sqrt{2.5} \rightarrow \frac{1.2}{x} t^2$$

نیٹا "میسر" : از خط صاف کسیم !

$$MSE : 2.5$$

↓  
good

$$\xrightarrow{w} MSE : 1 \rightarrow \underline{\text{good}}$$

$\hat{y}$  : predicted

$y$  : true

$$L_{MSE} = \frac{1}{N} \sum_{i=1}^N (\hat{y}_i - y_i)^2$$

نمبر از میانگین  
و عمل چگونه در آن ها است

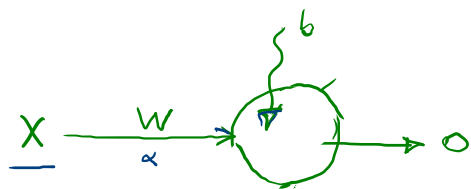
یا به هر دو عمل می شود؟

accuracy  $\uparrow$  loss fun  $\downarrow$

$\alpha$  : چگونه یاد را تغییر دهیم : min تابع هزینه را

★

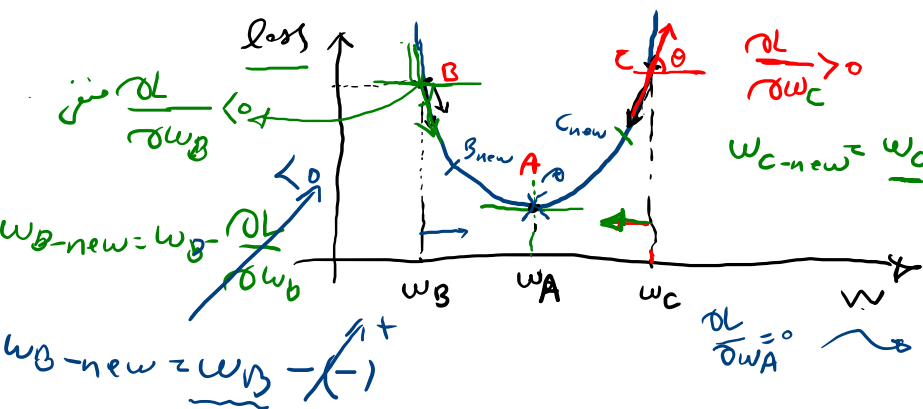




$$o = \hat{y} = \underline{wx + b}$$

$$\underline{loss} = mse = \frac{1}{N} \sum_{i=1}^N (\hat{y}_i - y_i)^2 = \frac{1}{N} \sum_{i=1}^N (wx_i + b - y_i)^2$$

$$Loss \propto w^2$$



$$\frac{\partial L}{\partial w_C} > 0$$

$$w_{C-new} = w_C - \frac{\partial L}{\partial w_C}$$

$$w_{new} = w_{old} - \nabla_w L = w_{old} - \frac{\partial L}{\partial w_{old}}$$

$$w_{A-new} = w_A - \frac{\partial L}{\partial w_A}$$

Gradient

گرادیان



max → تغییرات در:

$$\nabla F \rightsquigarrow \nabla F = \frac{\partial F}{\partial x} \hat{i} + \frac{\partial F}{\partial y} \hat{j}$$

max ←  $\nabla L$   $\rightsquigarrow$   $-\nabla L$   
min

Gradient Descent  $\leftarrow$  optimizer

$$w_{\text{new}} = w_{\text{old}} - \alpha \frac{\partial L}{\partial w_{\text{old}}}$$

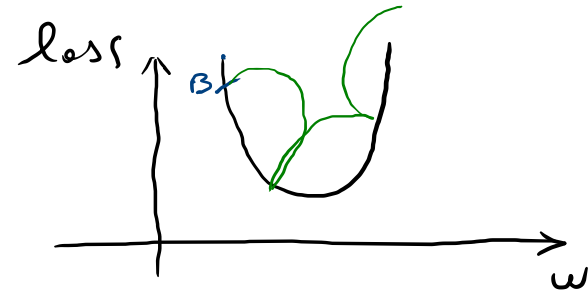
MSE

Learning Rate

$\cdot 1$

$\cdot 0.1$

$\vdots$

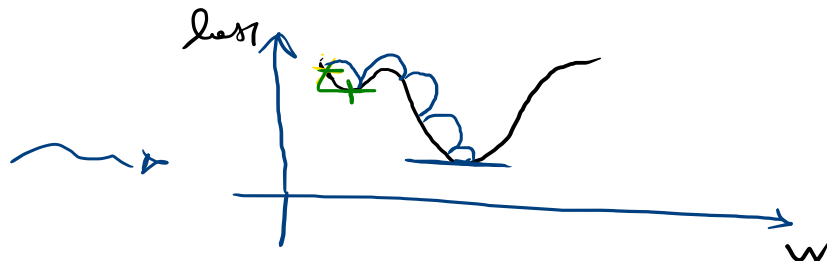
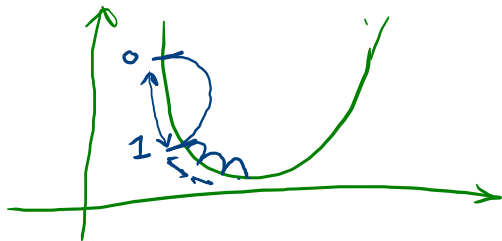


حل

$w_{new} = w_{old}$  ←  $\frac{\partial L}{\partial w} = 0$  ← حل

programming

iteration, like → HP

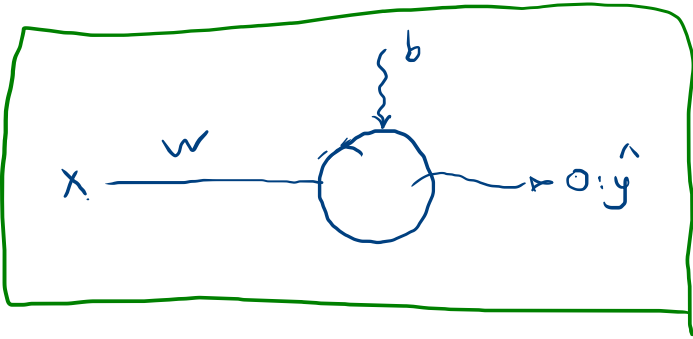


✓ میزان هزینه را کم می‌کنیم  
 ✓ به سمت چپ حرکت می‌کنیم (در جهت منفی)

$$w_{\text{new}} = w_{\text{old}} - \alpha \frac{\partial L}{\partial w_{\text{old}}}$$

Learning rate!

# Example



$$\begin{cases} x = \underline{8} \\ w = \underline{1} \\ b = \underline{1} \end{cases}$$

area	price
4	9
<u>8</u>	<u>17</u>

A green arrow points from the underlined '8' in the 'area' column to the underlined '17' in the 'price' column.

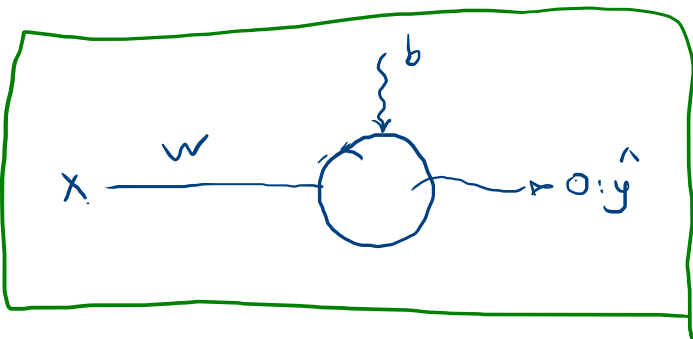
$$\hat{y} = wx + b = (1)(8) + 1 = 9$$

$$MSE = \frac{1}{N} (\hat{y} - y)^2 = \frac{(9 - 17)^2}{1} = \frac{64}{1}$$

# Example

$$\frac{1}{N} \sum$$

	area	price
→	4	9
→	8	17



$$\left\{ \begin{array}{l} x = 8 \\ w = 1 \\ b = 1 \end{array} \right.$$

$$\hat{y} = wx + b = w(8) + b \rightarrow \hat{y} = w(8) + b$$

$$Loss = (w(8) + b - 17)^2 = (8w + b - 17)^2$$

$$\text{Loss} = (\underline{8w + b - 17})^2$$

$$\frac{\partial L}{\partial w} = 2(8)(8w + b - 17) = 16(8w + b - 17)$$

$$\left\{ \begin{array}{l} w_{\text{new}} = w_{\text{old}} - \frac{\partial L}{\partial w_{\text{old}}} \\ b_{\text{new}} = b_{\text{old}} - \frac{\partial L}{\partial b_{\text{old}}} \end{array} \right.$$

$$b=0 \rightarrow \frac{\partial L}{\partial w} = 16(8w - 17)$$

$$w_{\text{new}} = w_{\text{old}} - \underset{\alpha = 0.1}{16(8w_{\text{old}} - 17)} = 1 - 16(8 - 17) =$$

$$= 1 - (16)(-9) =$$

$$= 143$$



$$\hat{y} = wX = 143 \times 8 = \$ \underline{1144}$$

$$\hat{y}_1 = 64$$

$$\hat{y}_2 = \underline{1144}$$

←  $\alpha$  ~~میزان~~ ~~تغییر~~

$$\alpha = 0.01$$

←  $\alpha$  ~~تغییر~~

$$\underline{-144}$$

$$w_{new} = w_{old} - (0.01)(16)(8w_{old} - 17) =$$

$$w_{new} = 1 - 0.01(-144) = 1 + 1.44 = \underline{2.44}$$

$$\hat{y} = w x + \underline{b} \rightarrow \hat{y} = 2,44(8) \approx 20$$

$$\hat{y} = 20 \leftarrow \text{نص}$$

$$\hat{y} = 8 \text{ نص}$$

$$MSE = (20 - 17)^2 = 9$$

$$MSE_{\text{نص}} = 64$$

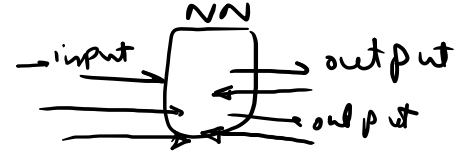
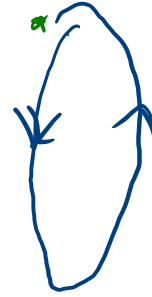
$$MSE_{\text{نص}} = 9$$

optimization  
process

↑  
y

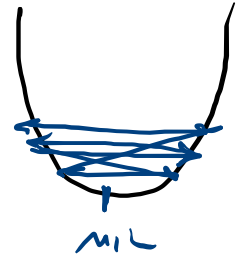
۱. حوضی در سطح در در صاف را - را گنجه ←

۲. تابع هزینه را - را گنجه ← loss func.



۳. از طریق Optimizer بهینه ساز به وزن ها را درست  
که هر داده که می آید

گنجه!



! (optimization process)  $\alpha$  طرہ لا اینہ دوسرے

مکلف روی  $\{ \underline{N} \underline{N} \}$  سے کیا کر سکتے ہیں؟



مکلفی سے!

End