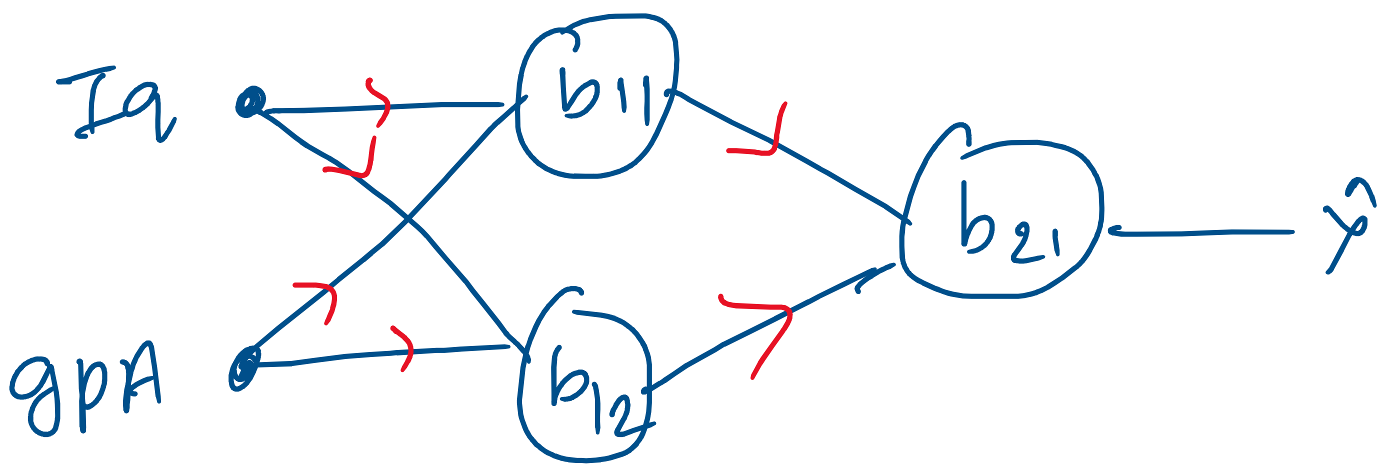
DL Week-03-CS-01

Sunday, February 22, 2026 9:51 PM

Back propagation → Algorithm → Train N N → weight / bias

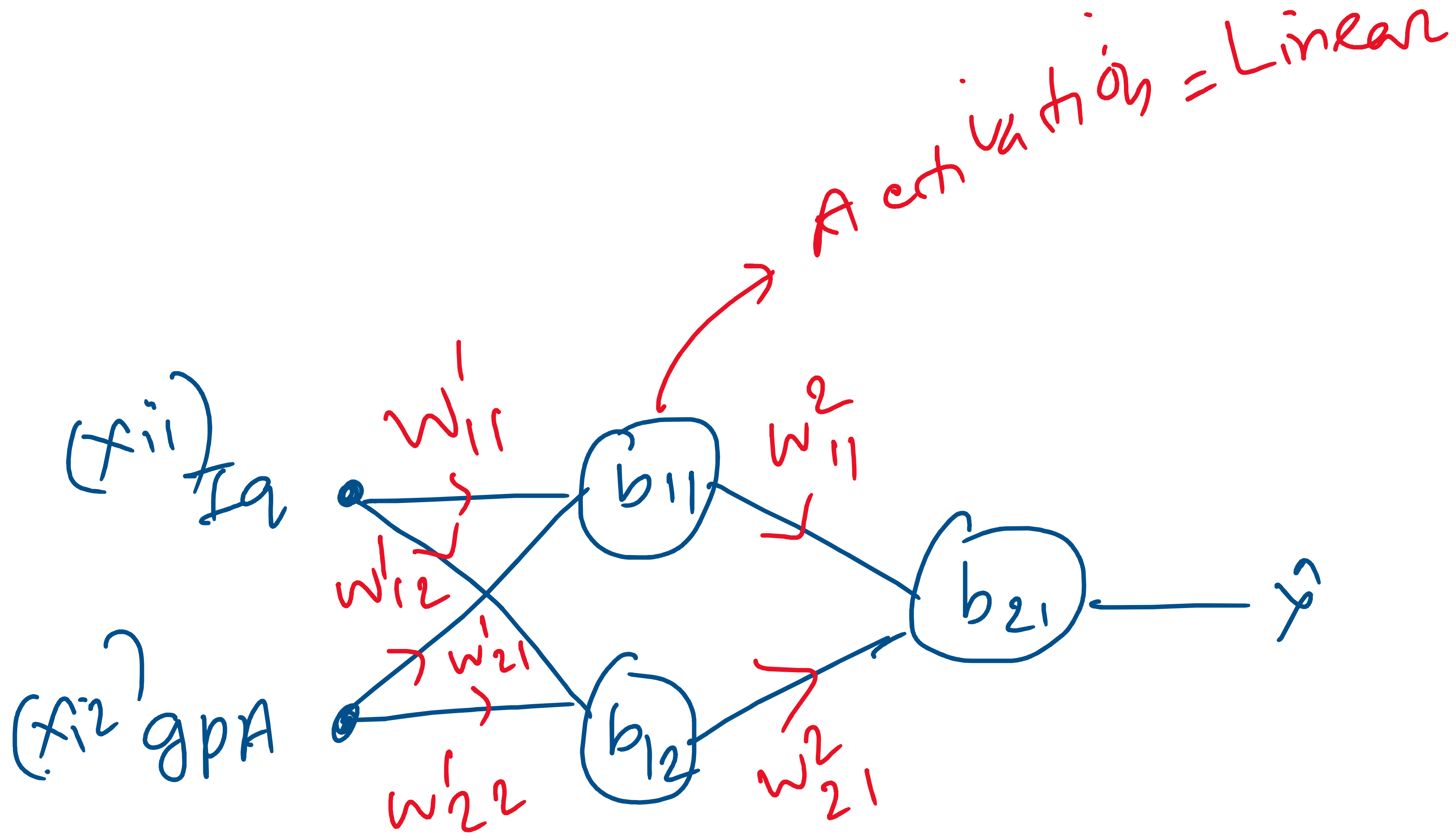
Iq	gpA	Salary
60	3.5	40
80	4.7	60
20	3	25
90	3	50



* Gradient Descent
* Forward propagation

How BP work

Iq	gpA	Salary
→ 60	3.5	40
80	4.7	60
20	3	25
90	3	50



regression

Step :

0) Initialization w, b → (w, b) → Random Values

→ (w, b) → $\boxed{w = 1, b = 0}$ → $\boxed{\text{predict} \rightarrow 60}$

1) select a row

2) Predict (salary) → Forward propagation

3) choose a Loss Function (MSE) → Regression Problem

$$\boxed{L = (y - \hat{y})^2}$$

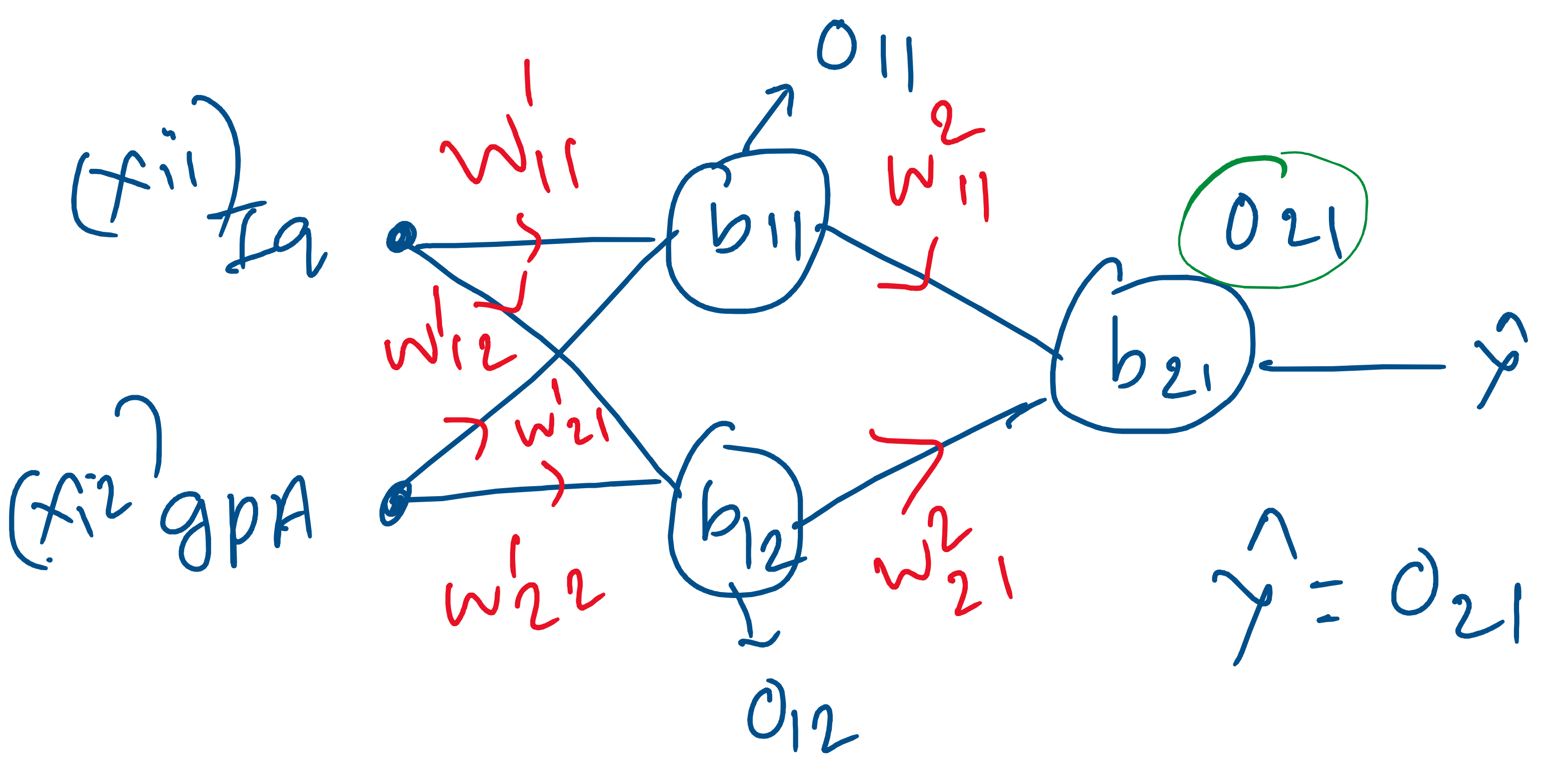
$$= (40 - 60)^2$$

$$= 400 \leftarrow \boxed{\text{error}}$$

4) weights and bias update
↓
Gradient descent

$y \rightarrow x$

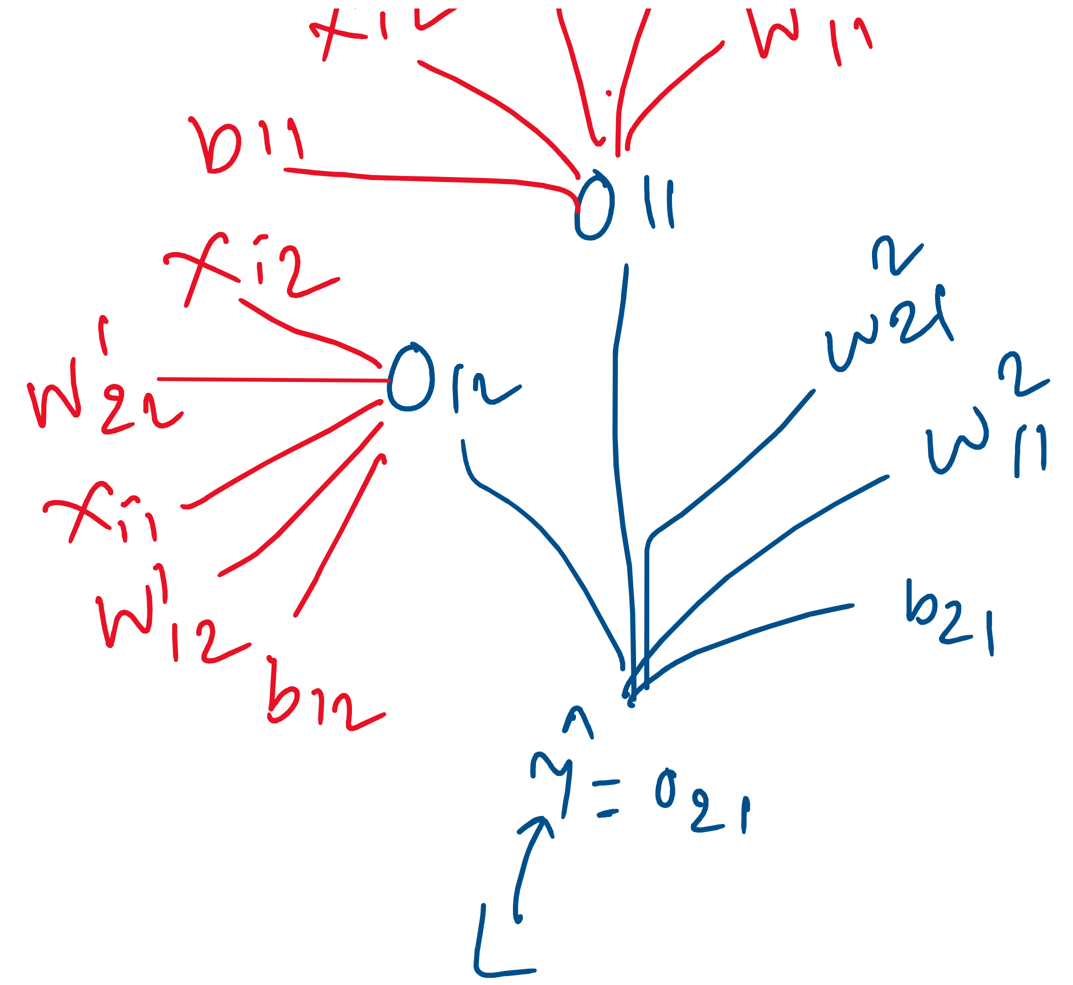
$\hat{y} \rightarrow \checkmark$



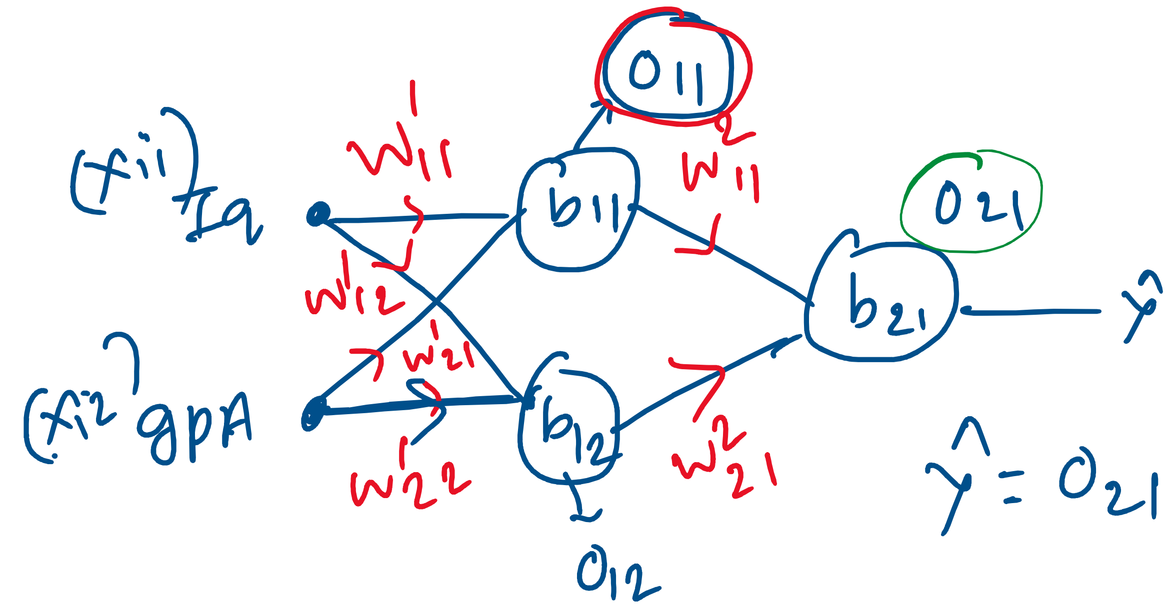
$$\hat{y} = O_{21} = w^2_{11} O_{11} + w^2_{21} O_{12} + b_{21}$$

$L \downarrow \min = \hat{y}$

$$\boxed{\ldots = w^1_{..} x_{i1} + w^1_{22} x_{i2} + b_{12}}$$



$$\boxed{O_{12} = w^1_{12}\, x_{i1} + w^1_{22}\, x_{i2} + b_{12}}$$

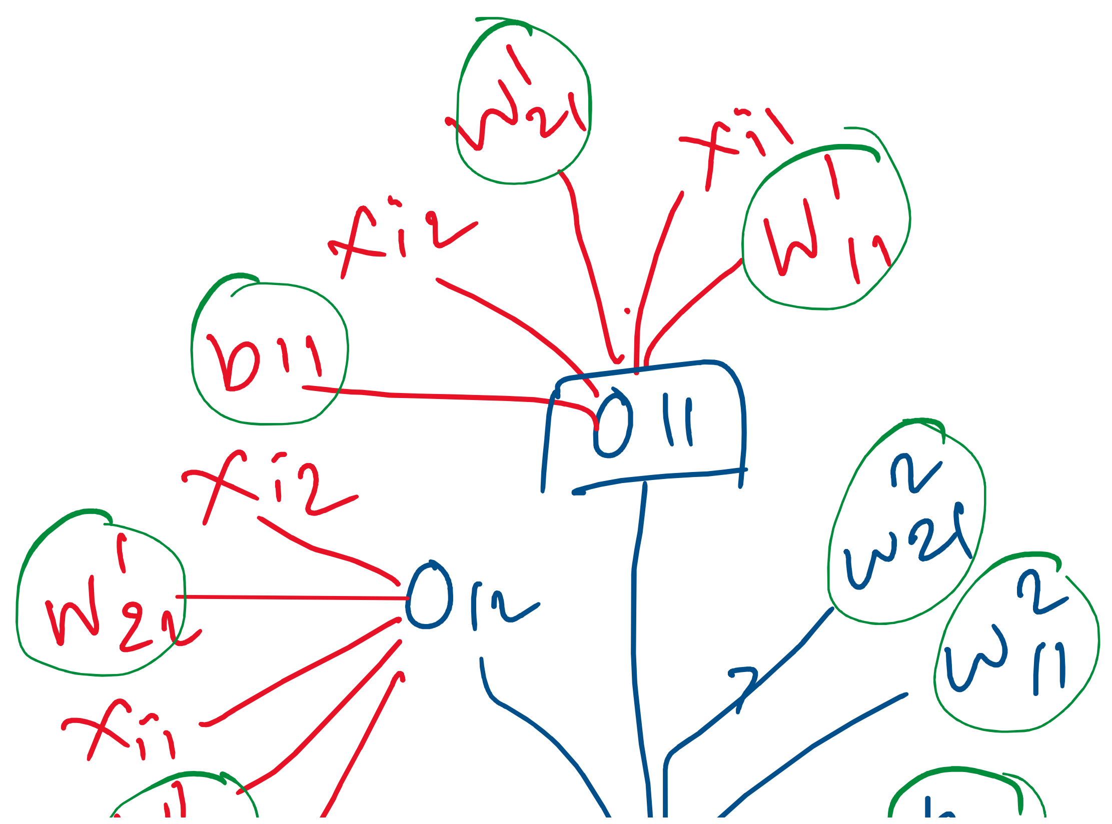


$$O_{11} = \boxed{w^1_{11}\, x_{i1} + w^1_{21}\, x_{i2} + b_{11}}$$

Gradient Descent

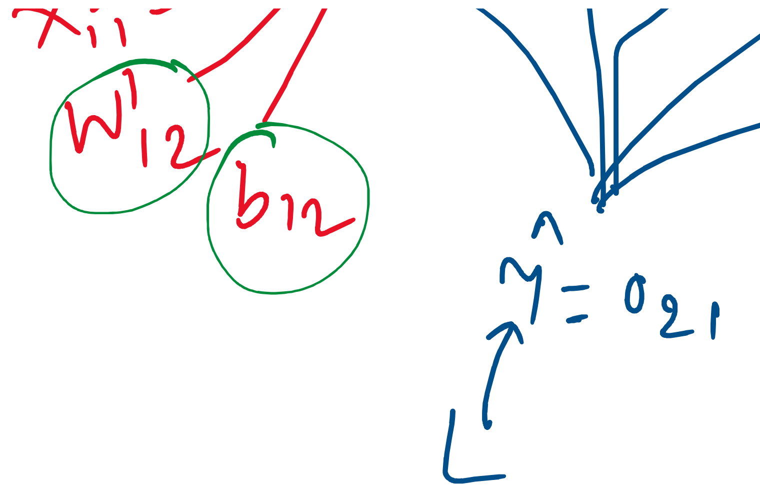
$$w_{new} = \boxed{w_{old}} - \overset{0.1}{\eta} \boxed{\frac{\partial L}{\partial w_{old}}} \checkmark$$

$$b_{new} = b_{old} - \eta \boxed{\frac{\partial L}{\partial b_{old}}} \checkmark$$



$$\frac{\partial L}{\partial w^2_{21}}, \quad \frac{\partial L}{\partial w^2_{11}}, \quad \frac{\partial L}{\partial b_{21}}$$

$$\frac{\partial L}{\partial w^1_{11}}, \quad \frac{\partial L}{\partial w^1_{21}}, \quad \frac{\partial L}{\partial b_{11}}$$



∂w^1_{11} , ∂w^1_{21} ∂b_{11}

$$\frac{\partial L}{\partial w^1_{22}}, \frac{\partial L}{\partial w^1_{12}}, \frac{\partial L}{\partial b_{12}}$$

$$\boxed{\frac{\partial L}{\partial w^2_{21}}, \frac{\partial L}{\partial w^2_{11}}, \frac{\partial L}{\partial b_{21}}} \rightarrow \text{finding}$$

change

change

w^2_{11}

$\hat{y}$

L (min)

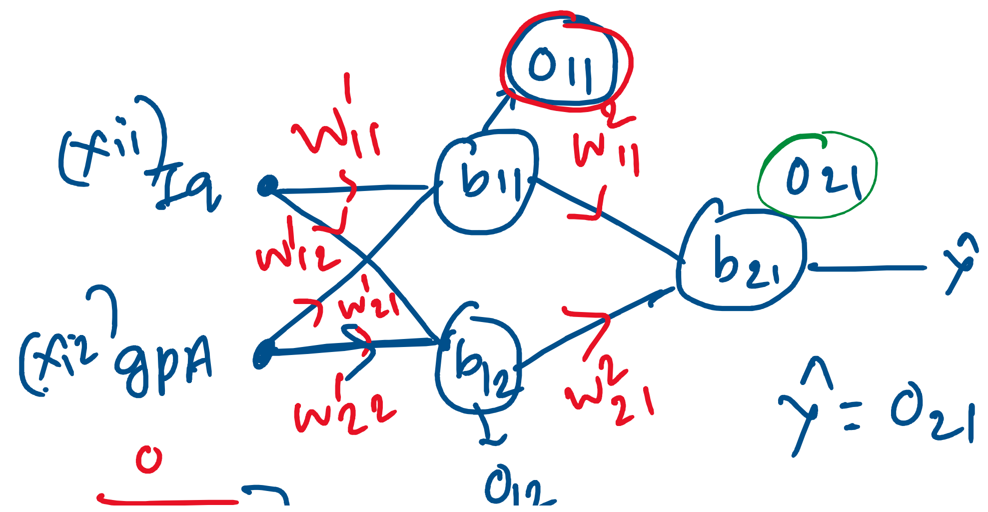
$$\frac{\partial L}{\partial w^2_{21}} = \boxed{\frac{\partial L}{\partial \hat{y}} \times \frac{\partial \hat{y}}{\partial w^2_{21}}} \rightarrow \text{chain rule of differentiation}$$

$$\frac{\partial L}{\partial w^2_{11}} = \frac{\partial L}{\partial \hat{y}} \frac{\partial \hat{y}}{\partial w^2_{11}}$$

$$\frac{\partial L}{\partial \hat{y}} = \frac{\partial}{\partial \hat{y}} (y-\hat{y})^2$$

$$\hookrightarrow = -2(y-\hat{y})$$

$$\boxed{\frac{\partial L}{\partial \hat{y}} = -2(y-\hat{y})}$$



$$\frac{\partial \hat{y}}{\partial w^2_{21}} = \frac{\partial}{\partial w^2_{21}}\left[\overset{0}{\overline{w^2_{11} O_{11}}} + \underline{w^2_{21} O_{12}} + \overset{0}{\overline{b_{21}}}\right]$$

$$\Rightarrow = O_{12}$$

$$\frac{\partial L}{\partial w^2_{21}} = \frac{\partial L}{\partial \hat{y}} \times \frac{\partial \hat{y}}{\partial w^2_{21}} = -2(y-\hat{y})\, O_{12}$$

$$\frac{\partial L}{\partial w^2_{11}} = \frac{\partial L}{\partial \hat{y}} \frac{\partial \hat{y}}{\partial w^2_{11}} = -2(y-\hat{y})\, O_{11}$$

$$\frac{\partial \hat{y}}{\partial w^2_{11}} = \frac{\partial}{\partial w^2_{11}}\left[\underline{w^2_{11} O_{11}} + \underset{0}{\underline{w^2_{21}}}\, O_{12} + \underset{0}{\underline{b_{21}}}\right]$$

$$\Rightarrow = O_{11}$$

$$\frac{\partial L}{\partial b_{21}} = \frac{\partial L}{\partial \hat{y}} \frac{\partial \hat{y}}{\partial b_{21}} = -2(y-\hat{y})$$

$$\frac{\partial \hat{y}}{\partial b_{21}} = \frac{\partial}{\partial b_{21}}\left[\underset{0}{\underline{w^2_{11} O_{11}}} + \underset{0}{\underline{w^2_{21}}}\, O_{12} + b_{21}\right]$$

$$= 1$$

$$= 1$$

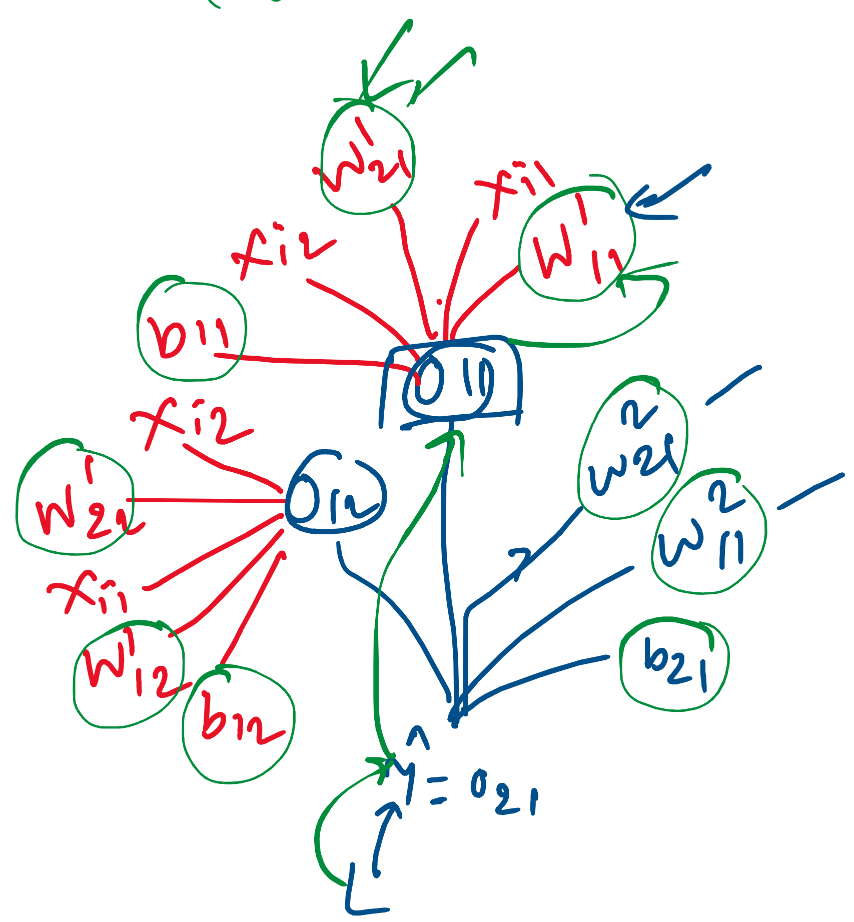
$$\frac{\partial L}{\partial w^2_{21}} = -2(y-\hat{y})\, o_{12}$$

$$\frac{\partial L}{\partial w^2_{11}} = -2(y-\hat{y})\, o_{11}$$

$$\frac{\partial L}{\partial b_{21}} = -2(y-\hat{y})$$

$$\boxed{\frac{\partial L}{\partial w^1_{11}},\ \frac{\partial L}{\partial w^1_{21}},\ \frac{\partial L}{\partial b_{11}}} \Rightarrow \text{Finding}$$

$$\frac{\partial L}{\partial \hat{y}} = -2(y-\hat{y})$$



$$\frac{\partial L}{\partial w^1_{11}} = \frac{\partial L}{\partial \hat{y}} \times \frac{\partial \hat{y}}{\partial o_{11}} \times \frac{\partial o_{11}}{\partial w^1_{11}}$$

$$\frac{\partial L}{\partial w^1_{21}} = \frac{\partial L}{\partial \hat{y}}\ \frac{\partial \hat{y}}{\partial o_{11}}\ \frac{\partial o_{11}}{\partial w^1_{21}}$$

$$\frac{\partial L}{\partial b_{11}} = \frac{\partial L}{\partial \hat{y}} \frac{\partial \hat{y}}{\partial O_{11}} \frac{\partial O_{11}}{\partial b_{11}}$$

$$L \rightarrow \hat{y} \rightarrow O_{11} \rightarrow W^1_{11}$$

$$\frac{\partial \hat{y}}{\partial O_{11}} = \frac{\partial}{\partial O_{11}} \left[W^2_{11} O_{11} + \underbrace{W^2_{21} O_{12}}_{0} + \underbrace{b_{21}}_{0} \right]$$

$$\hookrightarrow = W^2_{11}$$

$$\left[W^1_{11} x_{i1} + W^1_{21} x_{i2} + b_{11} \right]$$

$$\frac{\partial O_{11}}{\partial W^1_{11}} = \frac{\partial}{\partial W^1_{11}} \left[W^1_{11} x_{i1} + \overbrace{W^1_{21}}^{0} x_{i2} + \overbrace{b_{11}}^{0} \right]$$

$$\hookrightarrow = x_{i1}$$

$$\frac{\partial O_{11}}{\partial W^1_{21}} = \frac{\partial}{\partial W^1_{21}} \left[\overbrace{W^1_{11} x_{i1}}^{0} + W^1_{21} x_{i2} + \overbrace{b_{11}}^{0} \right]$$

$$\hookrightarrow = x_{i2}$$

$$\frac{\partial O_{11}}{\partial b_{11}} = \frac{\partial}{\partial b_{11}} \left[\underbrace{W^1_{11} x_{i1}}_{0} + \underbrace{W^1_{21} x_{i2}}_{0} + b_{11} \right]$$

$$= 1$$

$$\frac{\partial L}{\partial \hat{y}} = -2(y - \hat{y})$$

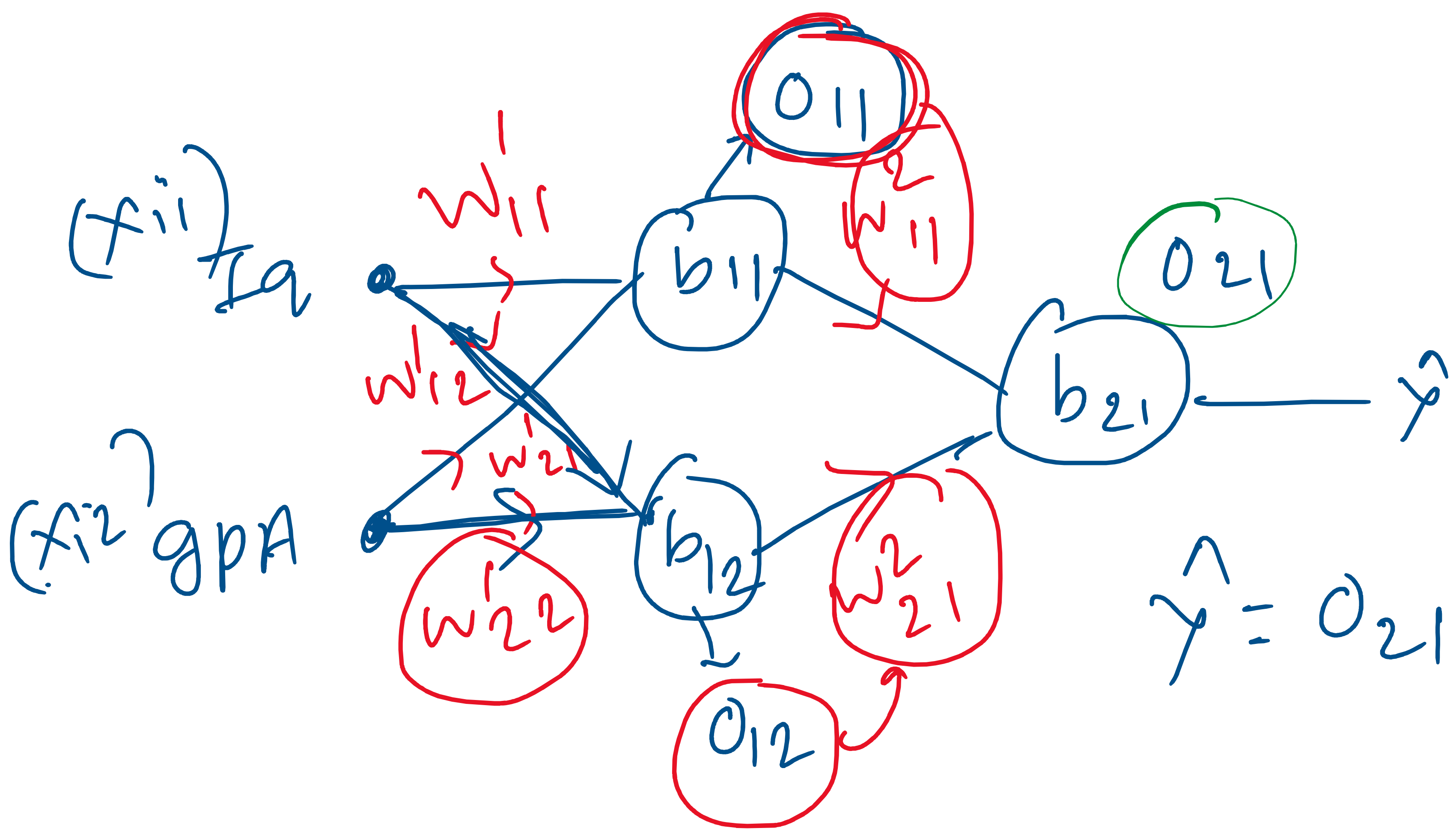
$$\frac{\partial \hat{y}}{\partial O_{11}} = W^2_{11}$$

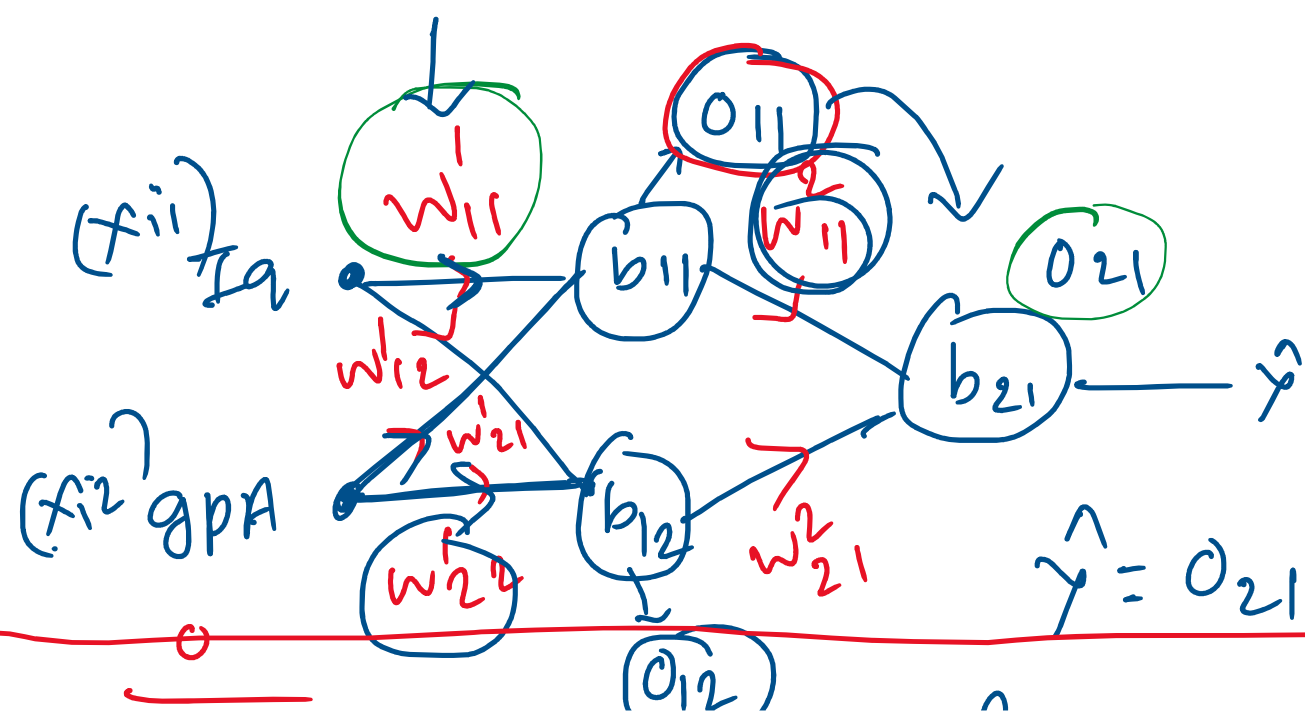
$$\frac{\partial L}{\partial W^1_{11}} = \frac{\partial L}{\partial \hat{y}} \times \frac{\partial \hat{y}}{\partial O_{11}} \times \frac{\partial O_{11}}{\partial W^1_{11}} = -2(y - \hat{y}) \, W^2_{11} \, x_{i1}$$

$$\frac{\partial L}{\partial w^1_{11}} = \frac{\partial L}{\partial \hat{y}} \cdot \frac{\partial \hat{y}}{\partial O_{11}} \frac{\partial O_{11}}{\partial w^1_{11}} = -2(y - \hat{y})\, w^2_{11}\, x_{i1}$$

$$\frac{\partial L}{\partial w^1_{21}} = \frac{\partial L}{\partial \hat{y}} \frac{\partial \hat{y}}{\partial O_{11}} \frac{\partial O_{11}}{\partial w^1_{21}} = -2\,(y - \hat{y})\, w^2_{11}\, x_{i2}$$

$$\frac{\partial L}{\partial b_{11}} = \frac{\partial L}{\partial \hat{y}} \frac{\partial \hat{y}}{\partial O_{11}} \frac{\partial O_{11}}{\partial b_{11}} = -2(y - \hat{y})\, w^2_{11}$$





$$\frac{\partial L}{\partial w^1_{11}} = -2(y-\hat{y})\, w^2_{11}\, x_{i1}$$

$$\frac{\partial L}{\partial w^1_{21}} = -2(y-\hat{y})\, w^2_{11}\, x_{i2}$$

$$\frac{\partial L}{\partial b_{11}} = -2(y-\hat{y})\, w^2_{11}$$

$$\frac{\partial L}{\partial w^1_{22}} = -2(y-\hat{y})\, \underline{w^2_{21}}\, x_{i2}$$

$$\frac{\partial L}{\partial w^1_{12}} = -2(y-\hat{y})\, w^2_{21}\, x_{i1}$$

$$\frac{\partial L}{\partial b_{12}} = -2(y-\hat{y})\, w^2_{21}$$

$$\frac{\partial L}{\partial w^2_{21}} = -2(y-\hat{y})\, o_{12}$$

$$\frac{\partial L}{\partial w^2_{11}} = -2(y-\hat{y})\, o_{11}$$

$$\frac{\partial L}{\partial b_{21}} = -2(y-\hat{y})$$

$$\frac{\partial \hat{y}}{\partial w^2_{11}} = O_{11} \qquad \frac{\partial L}{\partial w^1_{11}} = -2(y-\hat{y})\, w^2_{11}\, x_{i1} \qquad \frac{\partial L}{\partial w^1_{12}} = -2(y-\hat{y})\, w^2_{21}\, x_{i1}$$

$$\frac{\partial \hat{y}}{\partial w^2_{21}} = O_{12} \qquad \frac{\partial L}{\partial w^1_{21}} = -2(y-\hat{y})\, w^2_{11}\, x_{i2} \qquad \frac{\partial L}{\partial w^1_{22}} = -2(y-\hat{y})\, w^2_{21}\, x_{i2}$$

$$\frac{\partial \hat{y}}{\partial b_{21}} = 1 \qquad \frac{\partial L}{\partial b_{11}} = -2(y-\hat{y})\, w^2_{11} \qquad \frac{\partial L}{\partial b_{12}} = -2(y-\hat{y})\, w^2_{21}$$

IQ	gpA	Salary
60	3.5	40
80	4.7	60
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90	3	50

Step

0) Initilization w/b → Random → $w = 1,\ b = 0$

Back propagation

1) for i in range(4):

epoch

loop( )

L (min)

*) Take a row → Forward Propagation → Predict (Salary)

*) Loss Function (MSE)

*) Adjust weights / bias

∂L

$\boxed{W,\ b \Rightarrow y}$

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

$$b_{new} = b_{old} - \eta \frac{\partial L}{\partial b_{old}}$$