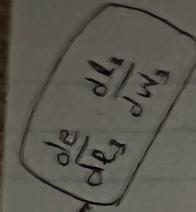


$$\begin{aligned}l_1 &= \sigma(w_1 x + b_1) \\l_2 &= \sigma(w_2 l_1 + b_2) \\l_3 &= \sigma(w_3 l_2 + b_3)\end{aligned}$$

3 layer NN



$$e = Y - l_3$$

$$\frac{\partial e}{\partial w_3} = (Y - l_3) \frac{\partial l_3}{\partial w_3} = \cancel{e} \underbrace{\sigma'(w_3 l_2 + b_3)}_{O_3} l_2 = O_3 l_2$$

$$\frac{\partial e}{\partial w_2} = (Y - l_3) \frac{\partial l_3}{\partial w_2} = \cancel{e} \underbrace{\sigma'(w_3 l_2 + b_3) \cdot \frac{\partial l_2}{\partial w_2}}_{O_3} \cdot w_3$$

$$\begin{aligned}\frac{\partial}{\partial w_2} &\quad \boxed{l_3 = \sigma(w_3 \sigma(w_2 l_1 + b_2) + b_3)} \\&= e \cdot \sigma'(w_3 l_2 + b_3) \cdot w_3 \cdot \sigma'(w_2 l_1 + b_2) \cdot l_1 \\&= \underbrace{O_3 \cdot w_3 \cdot \sigma'(w_2 l_1 + b_2)}_{O_2} l_1 = O_2 l_1\end{aligned}$$

$$\frac{\partial e}{\partial w_1} = (Y - l_3) \frac{\partial l_3}{\partial w_1} = e \cdot \sigma'(w_3 l_2 + b_3) \cdot w_3 \cdot \frac{\partial l_2}{\partial w_1}$$

$$= e \cdot \sigma'(w_3 l_2 + b_3) \cdot w_3 \cdot \sigma'(w_2 l_1 + b_2) \cdot w_2 \cdot \frac{\partial l_1}{\partial w_1}$$

$$= e \cdot \sigma'(w_3 l_2 + b_3) \cdot w_3 \cdot \sigma'(w_2 l_1 + b_2) \cdot w_2 \cdot \sigma'(w_1 x + b_1) \cdot x$$

$$= \underbrace{O_2 \cdot w_2 \cdot \sigma'(w_1 x + b_1)}_{O_{31}} \cdot x$$

$$= O_1 x$$

Update
eqns

$$w_3 = w_3 + \alpha \frac{\partial e}{\partial w_3} = w_3 + \alpha O_3 l_2$$

$$w_2 = w_2 + \alpha \frac{\partial e}{\partial w_2} = w_2 + \alpha O_2 l_1$$

$$w_1 = w_1 + \alpha \frac{\partial e}{\partial w_1} = w_1 + \alpha O_1 x$$