



$$h_1 = W_{xh} \times x_1 + W_{hh} \times h_0 + b_1$$

$$h_2 = W_{xh} \times x_2 + W_{hh} \times h_1 + b_2$$

$$h_3 = W_{xh} \times x_3 + W_{hh} \times h_2 + b_3$$

$$o = W_{ho} \times h_3 + b_o$$

$$l = (o - y)^2$$

$$\frac{\partial l}{\partial o} = 2 \times (o - y)$$

$$\frac{\partial o}{\partial h_3} = W_{ho} \quad \frac{\partial h_3}{\partial W_{hh}} = h_2 \quad \frac{\partial h_3}{\partial W_{xh}} = x_3$$

$$\frac{\partial h_3}{\partial h_2} = W_{hh} \quad \frac{\partial h_2}{\partial W_{hh}} = h_1 \quad \frac{\partial h_2}{\partial W_{xh}} = x_2$$

$$\frac{\partial h_2}{\partial h_1} = W_{hh} \quad \frac{\partial h_1}{\partial W_{hh}} = h_0 \quad \frac{\partial h_1}{\partial W_{xh}} = x_1$$

$$\begin{aligned} \frac{\partial l}{\partial W_{hh}} &= \frac{\partial l}{\partial o} \times \frac{\partial o}{\partial h_3} \times \frac{\partial h_3}{\partial W_{hh}} + \frac{\partial l}{\partial o} \times \frac{\partial o}{\partial h_3} \times \frac{\partial h_3}{\partial h_2} \times \frac{\partial h_2}{\partial W_{hh}} \\ &\quad + \frac{\partial l}{\partial o} \times \frac{\partial o}{\partial h_3} \times \frac{\partial h_3}{\partial h_2} \times \frac{\partial h_2}{\partial h_1} \times \frac{\partial h_1}{\partial W_{hh}} \\ &= 2 \times (o - y) \times W_{ho} \times (h_2 + W_{hh} \times h_1 + W_{hh}^2 \times h_0) \end{aligned}$$

$$\begin{aligned} \frac{\partial l}{\partial W_{xh}} &= \frac{\partial l}{\partial o} \times \frac{\partial o}{\partial h_3} \times \frac{\partial h_3}{\partial W_{xh}} + \frac{\partial l}{\partial o} \times \frac{\partial o}{\partial h_3} \times \frac{\partial h_3}{\partial h_2} \times \frac{\partial h_2}{\partial W_{xh}} \\ &\quad + \frac{\partial l}{\partial o} \times \frac{\partial o}{\partial h_3} \times \frac{\partial h_3}{\partial h_2} \times \frac{\partial h_2}{\partial h_1} \times \frac{\partial h_1}{\partial W_{xh}} \\ &= 2 \times (o - y) \times W_{ho} \times (x_3 + W_{hh} \times x_2 + W_{hh}^2 \times x_1) \end{aligned}$$