

$$h_1 = x \cdot w_1 = [1 \quad 2 \quad 1 \quad 0] \cdot \begin{bmatrix} 1 & 0 & 1 \\ 1 & 1 & 0 \\ 0 & 0 & 1 \\ 1 & 1 & 1 \end{bmatrix} = [3 \quad 2 \quad 2]$$

$$h_2 = h_1 \cdot w_2 = [3 \quad 2 \quad 2] \cdot \begin{bmatrix} 1 & 1 \\ 1 & 0 \\ 0 & 1 \end{bmatrix} = [5 \quad 5]$$

$$z = h_2 \cdot w_3 = [5 \quad 5] \cdot \begin{bmatrix} 0 \\ 1 \end{bmatrix} = [5]$$

$$f = z - y = [5] - [10] = [-5]$$

$$L = f^2 = [25]$$

$$\frac{\partial L}{\partial f} = 2f = [-10]$$

$$\frac{\partial f}{\partial z} = y$$

$$\frac{\partial L}{\partial z} = \frac{\partial L}{\partial f} \cdot \frac{\partial f}{\partial z} = [-10] \cdot [10] = [-100]$$

$$\frac{\partial z}{\partial w_3} = h_2$$

$$\frac{\partial L}{\partial w_3} = \frac{\partial L}{\partial z} \cdot \frac{\partial z}{\partial w_3} = [-100] \cdot [5 \quad 5] = [-500 \quad -500]$$

$$\frac{\partial h_2}{\partial w_2} = h_1 \quad \frac{\partial z}{\partial h_2} = w_3$$

$$\frac{\partial L}{\partial h_2} = \frac{\partial L}{\partial z} \cdot \frac{\partial z}{\partial h_2} = [-100] \cdot \begin{bmatrix} 0 \\ 1 \end{bmatrix}^T = [0 \quad -100]$$

$$\frac{\partial L}{\partial w_2} = \frac{\partial L}{\partial h_2} \cdot \frac{\partial h_2}{\partial w_2} = [0 \quad -100]^T \cdot [3 \quad 2 \quad 2] = \begin{bmatrix} 0 & 0 & 0 \\ -300 & -200 & -200 \end{bmatrix}$$

$$\frac{\partial h_1}{\partial w_1} = x \quad \frac{\partial h_2}{\partial h_1} = w_2$$

$$\frac{\partial L}{\partial h_1} = \frac{\partial L}{\partial h_2} \cdot \frac{\partial h_2}{\partial h_1} = [0 \quad -100] \cdot \begin{bmatrix} 1 & 0 \\ 1 & 0 \\ 1 & 1 \end{bmatrix}^T = [0 \quad 0 \quad -100]$$

$$\frac{\partial L}{\partial w_1} = \frac{\partial L}{\partial h_1} \cdot \frac{\partial h_1}{\partial w_1} = [0 \quad 0 \quad -100]^T \cdot [1 \quad 2 \quad 1 \quad 0] = \begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ -100 & -200 & -100 & 0 \end{bmatrix}$$