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CSC321 HW3

1. $\mathbf{W} = \begin{bmatrix} 1 & -1 & 0 & 0 \\ 0 & 1 & -1 & 0 \\ 0 & 0 & 1 & -1 \end{bmatrix}$

$\mathbf{b} = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}$

$\mathbf{w} = \begin{bmatrix} -1 \\ -1 \\ -1 \end{bmatrix}$

$b = 0$

2.

$$\begin{tikzcd} x \arrow[r] \arrow[rrr, bend left] & z \arrow[r] & h \arrow[r] \arrow[d] & y \arrow[d] \\ & & R \arrow[dr] & S \arrow[dl] \\ & & \mathcal{E} & \end{tikzcd}$$

$\overline{\mathcal{E}} = 1$

$\overline{R} = \overline{\mathcal{E}} \cdot 1 \qquad \overline{S} = \overline{\mathcal{E}} \cdot 1$

$\overline{y} = \overline{S} \cdot (y - s)$

$\overline{h} = (W^{(2)})^T \overline{y} + r\overline{R}$

$\overline{z} = \sigma'(z)\, \overline{h}$

$\overline{x} = (W^{(1)})^T \overline{z} + \mathbf{1}_{N\times N}(y - s)$

$$\overline{x} = (W^{(1)})^T (\sigma'(z))^T \left((W^{(2)})^T (y-s) + r\right) + \mathbf{1}_{N\times N}(y-s)$$

3. $y = w_1 h_1 + w_5 h_2$

$h_1 = \mathrm{ReLU}(w_2 h_3 + h_4)$ $\qquad \mathrm{ReLU}'(z) = \begin{cases} 1 & \text{if } z \geq 0 \\ 0 & \text{if } z < 0 \end{cases}$

$h_2 = \mathrm{ReLU}(w_4 h_3 + h_4)$

$h_3 = \mathrm{ReLU}(w_3 x_1 + x_2)$ $\qquad \mathrm{ReLU}(z) = \begin{cases} z & \text{if } z \geq 0 \\ 0 & \text{if } z < 0 \end{cases}$

$h_4 = \mathrm{ReLU}(x_1 + x_2)$

$\boxed{h_1 = 0 \quad h_1' = 0}$

$\frac{\partial L}{\partial w_1} = (w_1 h_1 + w_5 h_2 - t) \cdot h_1$ $\qquad \boxed{\text{Yes}}$

$= 0$

$\frac{\partial L}{\partial w_2} = (w_1 \mathrm{ReLU}(w_2 h_3 + h_4) + w_5 h_2) \cdot w_1 \mathrm{ReLU}'(w_2 h_3 + h_4) \cdot h_3$

$= 0$ $\qquad \boxed{\text{Yes}}$

$$\frac{\partial L}{\partial w_3} = (w_1 h_1 + w_5 h_2)(w_1 h_1' + w_5 h_2')(w_2 h_3' + w_4 h_3') 2X_1$$

$$= w_5 h_2 \cdot w_5 h_2' (w_2 h_3' + w_4 h_3') 2X_1 \qquad \boxed{No}$$