2.1

let $w^T x = W_1 X + W_2 X$

$$h(w^T x_i + b) = \frac{1}{1+e^{-W_1x-W_2x-b}}$$

$$L(w,b) = -\frac{1}{M}\sum_{i=1}^{M}\left[y_i \log\left(\frac{1}{1+e^{-W_1x-W_2x-b}}\right) + (1-y_i)\left(\log\left(1-\frac{1}{1+e^{-W_1x-W_2x-b}}\right)\right)\right]$$

let $U_1 = \dfrac{1}{1+e^{-W_1x-W_2x-b}}$

$$\frac{\partial u_1}{\partial w_1} = \frac{xe^{-b-W_2x-W_1x}}{\left(e^{-b-W_2x-W_1x}+1\right)^2}$$

$$\frac{\partial u_2}{\partial w_2} = \frac{xe^{-b-W_2x-W_1x}}{\left(e^{-b-W_2x-W_1x}+1\right)^2} \qquad \frac{\partial v}{\partial b} = \frac{e^{b+W_1x+W_2x}}{\left(e^{b+W_1x+W_2x}+1\right)^2}$$

$$\frac{\partial L}{\partial w_1} = -\frac{1}{M}\sum_{i=1}^{M}\left[y_i \log(u) + (1-y_i)(\log(1-u))\right]$$

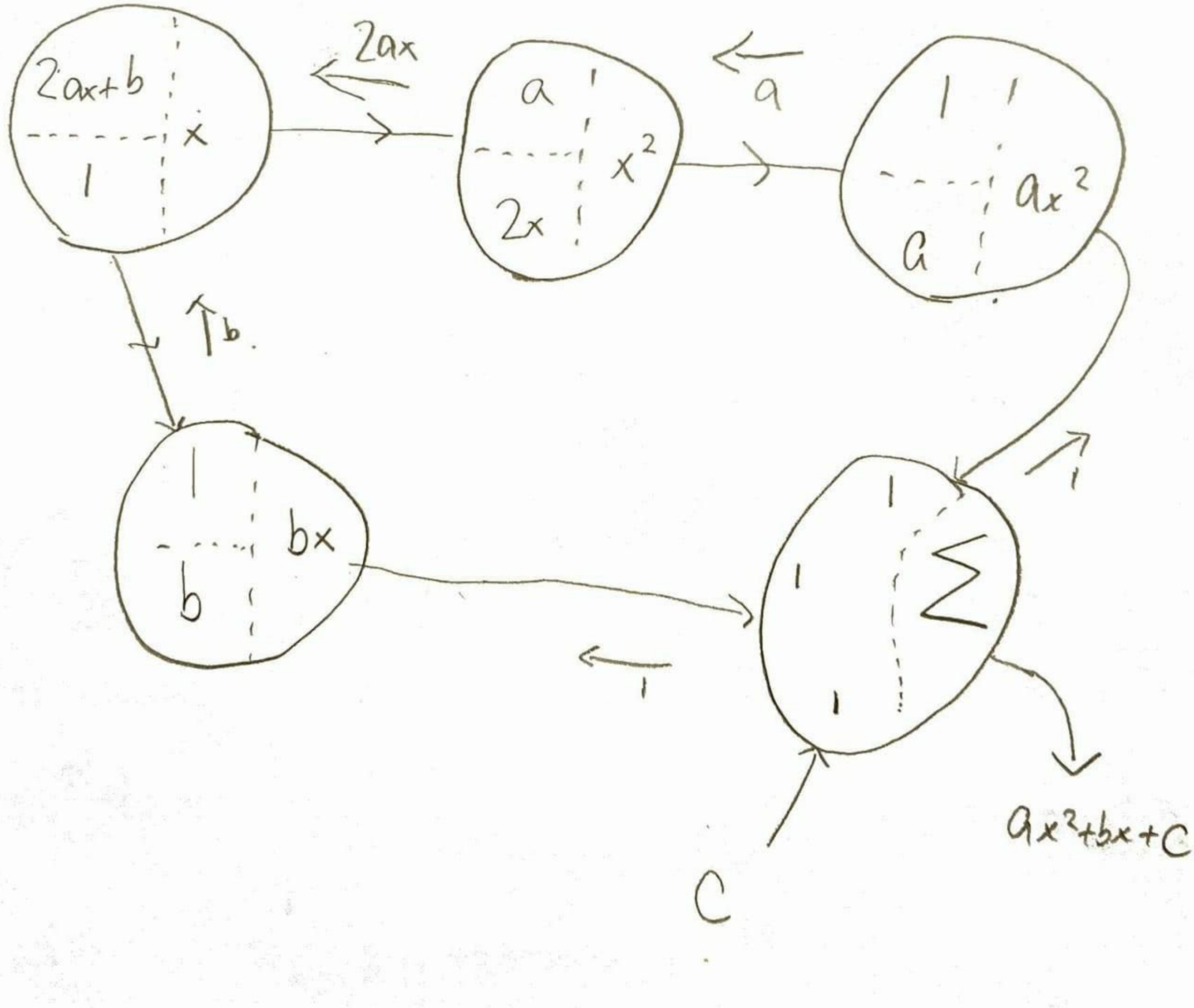
$$\frac{\partial L}{\partial u_1} = -\frac{1}{M}\sum_{i=1}^{M}\left[\frac{y_i}{u} + \frac{(1-y_i)}{u-1}\right]$$

$$\frac{\partial L}{\partial w_1} = \frac{\partial L}{\partial u_1}\cdot\frac{\partial u_1}{\partial w_1} = -\frac{1}{M}\sum_{i=1}^{M}\left[\frac{y_i\left(e^{-b-W_2x-W_1x}+1\right)}{xe^{-b-W_2x-W_1x}} + \frac{(1-y_i)\left(e^{-b-W_2x-W_1x}+1\right)}{xe^{-b-W_2x-W_1x}-\left(e^{-b-W_2x-W_1x}+1\right)}\right]$$

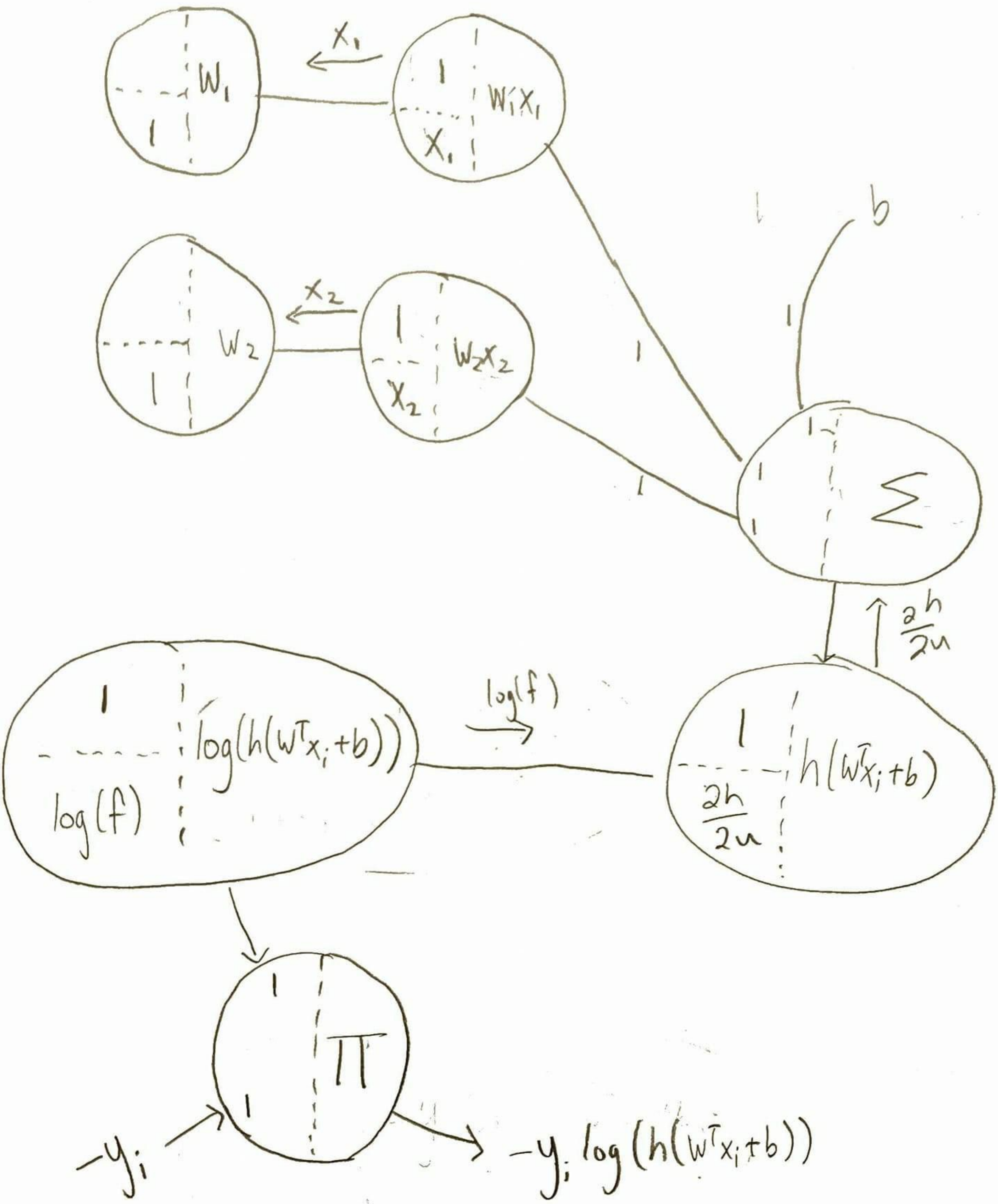
$$\frac{\partial L}{\partial w_2} = \frac{\partial L}{\partial u_2}\cdot\frac{\partial u_2}{\partial w_2} = -\frac{1}{M}\sum_{i=1}^{M}\left[\frac{y_i\left(e^{-b-W_2x-W_1x}+1\right)}{xe^{-b-W_2x-W_1x}} + \frac{(1-y_i)\left(e^{-b-W_2x-W_1x}+1\right)^2}{xe^{-b-W_2x-W_1x}-\left(e^{-b-W_2x-W_1x}+1\right)^2}\right]$$

$$\frac{\partial L}{\partial b} = \frac{\partial L}{\partial v}\cdot\frac{\partial v}{\partial b} = -\frac{1}{M}\sum_{i=1}^{M}\left[\frac{y_i\left(e^{b+W_1x+W_2x}+1\right)^2}{e^{b+W_1x+W_2x}} + \frac{(1-y_i)\left(e^{b+W_1x+W_2x}+1\right)^2}{e^{b+W_1x+W_2x}-e^{b+W_1x+W_2x}+1}\right]$$

2.2



2.3/2.4



x_1
w_1
1
1
$w_1 x_1$
x_1
x_2
w_2
1
1
$w_2 x_2$
x_2
b
1
1
1
1
1
1
Σ
$\frac{\partial h}{\partial u}$
$\log(f)$
1
$\log(h(w^T x_i + b))$
$\log(f)$
1
$h(w^T x_i + b)$
$\frac{\partial h}{\partial u}$
1
1
Π
$-y_i$
$-y_i \log(h(w^T x_i + b))$