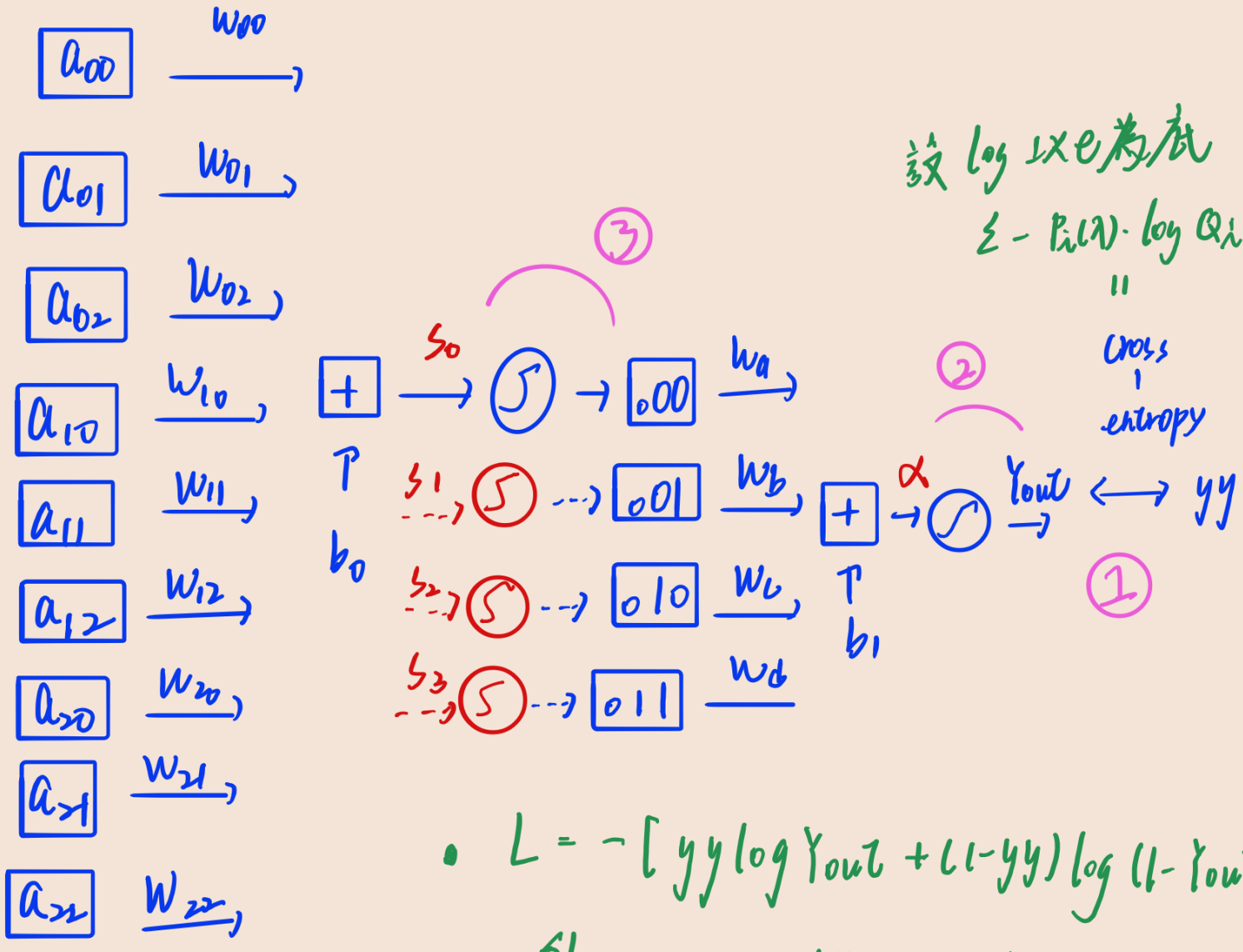

設 log 以 e 為底

$\Sigma - P_i(x) \cdot \log Q_i(x)$

=

- $L = -[yy \log y_{out} + (1-yy) \log (1-y_{out})]$

$$\frac{\partial L}{\partial y_{out}} = -\left[\frac{yy}{y_{out}} - \frac{1-yy}{1-y_{out}}\right]$$

$$= \frac{-yy}{y_{out}} + \frac{1-yy}{1-y_{out}}$$

- $\text{sigmoid}(x) = \frac{1}{1+e^{-x}}$

微分 $= \frac{e^{-x}}{(1+e^{-x})^2} = \sigma(x) \cdot (1-\sigma(x))$

- $\alpha = w_a \cdot o_{00} + w_b \cdot o_{01} + w_c \cdot o_{10} + w_d \cdot o_{11}$

1.

$$\frac{\partial l}{\partial w_{00}} = \frac{\partial l}{\partial y_{out}} \cdot \frac{\partial y_{out}}{\partial w_{00}}$$

$$= \frac{\partial l}{\partial y_{out}} \cdot \frac{\partial y_{out}}{\partial \alpha} \cdot \frac{\partial \alpha}{\partial w_{00}}$$

$$= \frac{\partial l}{\partial y_{out}} \cdot \frac{\partial y_{out}}{\partial \alpha} \cdot \left(\frac{\partial w_a \cdot o_{00}}{\partial s_0} \cdot \frac{\partial s_0}{\partial w_{00}} + \frac{\partial w_b o_{01}}{\partial s_1} \cdot \frac{\partial s_1}{\partial w_{00}} + \right.$$

$$\left. \frac{\partial w_c \cdot o_{10}}{\partial s_2} \cdot \frac{\partial s_2}{\partial w_{00}} + \frac{\partial w_d \cdot o_{11}}{\partial s_3} \cdot \frac{\partial s_3}{\partial w_{00}} \right)$$

$$= \frac{y_{out} - yy}{y_{out}(1 - y_{out})} * \frac{e^{-\alpha}}{(1 + e^{-\alpha})^2} *$$

$$\left(w_a \cdot \frac{e^{-s_0}}{(1+e^{-s_0})^2} \cdot a_{00} + w_b \cdot \frac{e^{-s_1}}{(1+e^{-s_1})^2} \cdot a_{01} + \right.$$

$$\left. w_c \cdot \frac{e^{-s_2}}{(1+e^{-s_2})^2} \cdot a_{10} + w_d \cdot \frac{e^{-s_3}}{(1+e^{-s_3})^2} \cdot a_{11} \right)$$

2. $\frac{\partial l}{\partial a_{21}} = \frac{\partial l}{\partial y_{out}} \cdot \frac{\partial y_{out}}{\partial a_{21}}$

$= \frac{\partial l}{\partial y_{out}} \cdot \frac{\partial y_{out}}{\partial \alpha} \cdot \frac{\partial \alpha}{\partial a_{21}}$

$= \frac{\partial l}{\partial y_{out}} \cdot \frac{\partial y_{out}}{\partial \alpha} * \left(\frac{\partial w_a \cdot o_{00}}{\partial s_0} \cdot \frac{\partial s_0}{\partial a_{21}} + \frac{\partial w_b o_{01}}{\partial s_1} \cdot \frac{\partial s_1}{\partial a_{21}} + \right.$

$\left. \frac{\partial w_c \cdot o_{10}}{\partial s_2} \cdot \frac{\partial s_2}{\partial a_{21}} + \frac{\partial w_d \cdot o_{11}}{\partial s_3} \cdot \frac{\partial s_3}{\partial a_{21}} \right)$

$= \frac{y_{out} - yy}{y_{out}(1 - y_{out})} * \frac{e^{-\alpha}}{(1+e^{-\alpha})^2} *$

$\left(w_a \cdot \frac{e^{-s_0}}{(1+e^{-s_0})^2} * w_{21} + w_b \cdot \frac{e^{-s_1}}{(1+e^{-s_1})^2} * w_{20} + \right.$

$\left. w_c \cdot \frac{e^{-s_2}}{(1+e^{-s_2})^2} * w_{11} + w_d \cdot \frac{e^{-s_3}}{(1+e^{-s_3})^2} * w_{10} \right)$