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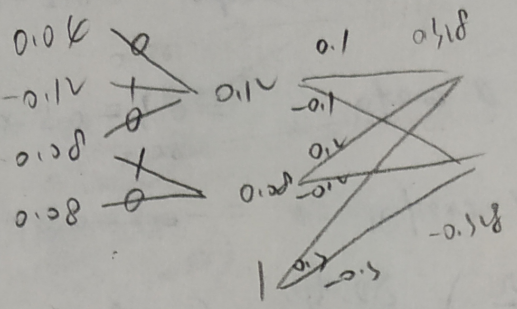
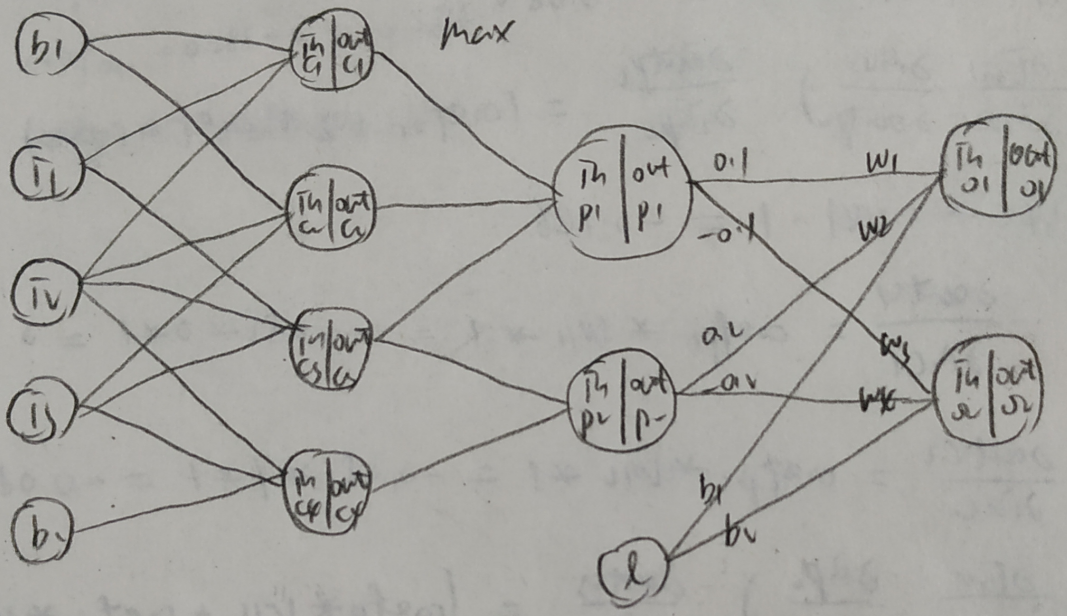


0 i_1 i_2 i_3 0

0 0.1 0.2 0.3 0

k_{13} k_{12} k_{11}

k_{13} k_{12} k_{11}



正向传播

$$in_{C_1} = i_1 * k_{12} + i_2 * k_{11} + b_1$$

$$in_{C_2} = i_2 * k_{13} + i_3 * k_{12} + b_1$$

$$in_{C_3} = i_1 * k_{22} + i_2 * k_{21} + b_2$$

$$in_{C_4} = i_2 * k_{23} + i_3 * k_{22} + b_2$$

$$in_{P_1} = \max(out_{C_1}, out_{C_2}, out_{C_3})$$

$$in_{P_2} = \max(out_{C_3}, out_{C_4})$$

$$in_{O_1} = w_1 \cdot outp_1 + w_2 \cdot outp_2 + b_1$$

$$in_{O_2} = w_3 \cdot outp_1 + w_4 \cdot outp_2 + b_2$$

反向传播

$coef_{o1} = \frac{\partial E_{total}}{\partial in_{o1}} = out_{o1} - o_1 = 0.658 - 1 = -0.341$

$coef_{o2} = \frac{\partial E_{total}}{\partial in_{o2}} = out_{o2} - o_2 = 0.341 - 0 = 0.341$

$w_1 = w_1 - \alpha \frac{\partial E_{total}}{\partial w_1} = w_1 - \alpha \frac{\partial E_{total}}{\partial in_{o1}} \cdot \frac{\partial in_{o1}}{\partial w_1} = w_1 - \alpha \cdot coef_{o1} \cdot outp_1 = 0.1 - 0.5 * (-0.341) * 0.12 = 0.120$

$w_2 = w_2 - \alpha \frac{\partial E_{total}}{\partial w_2} = w_2 - \alpha \frac{\partial E_{total}}{\partial in_{o1}} \cdot \frac{\partial in_{o1}}{\partial w_2} = w_2 - \alpha \, coef_{o1} \cdot outp_2 = 0.2 - 0.5 * (-0.341) * 0.08 = 0.214$

$w_3 = w_3 - \alpha \frac{\partial E_{total}}{\partial w_3} = w_3 - \alpha \frac{\partial E_{total}}{\partial in_{o2}} \cdot \frac{\partial in_{o2}}{\partial w_3} = w_3 - \alpha \cdot coef_{o1} \cdot outp_1 = -0.1 - 0.5 * 0.341 * 0.12 = -0.120$

$w_4 = w_4 - \alpha \frac{\partial E_{total}}{\partial w_4} = w_4 - \alpha \frac{\partial E_{total}}{\partial in_{o2}} \cdot \frac{\partial in_{o2}}{\partial w_4} = w_4 - \alpha \cdot coef_{o2} \cdot outp_2 = -0.2 - 0.5 * 0.341 * 0.08 = -0.214$

$b_1 = b_1 - \alpha \frac{\partial E_{total}}{\partial b_1} = b_1 - \alpha \frac{\partial E_{total}}{\partial in_{o1}} \cdot \frac{\partial in_{o1}}{\partial b_1} = b_1 - \alpha \cdot coef_{o1} \cdot 1 = 0.3 - 0.5 * (-0.341) = 0.471$

$b_2 = b_2 - \alpha \frac{\partial E_{total}}{\partial b_2} = b_2 - \alpha \frac{\partial E_{total}}{\partial in_{o2}} \cdot \frac{\partial in_{o2}}{\partial b_2} = b_2 - \alpha \cdot coef_{o2} \cdot 1 = -0.3 - 0.5 * 0.341 = -0.471$

$coef_{p1} = \frac{\partial E_{total}}{\partial in_{p1}} = \left(\frac{\partial E_{total}}{\partial in_{o1}} \cdot \frac{\partial in_{o1}}{\partial outp_1} + \frac{\partial E_{total}}{\partial in_{o2}} \cdot \frac{\partial in_{o2}}{\partial outp_1} \right) \cdot \frac{\partial outp_1}{\partial in_{p1}} = (coef_{o1} \cdot w_1 + coef_{o2} \cdot w_3) \cdot 1$

$= (-0.342 * 0.12 + 0.341 * (-0.12)) \cdot 1 = -0.082$

$coef_{p2} = \frac{\partial E_{total}}{\partial in_{p2}} = \left(\frac{\partial E_{total}}{\partial in_{o1}} \cdot \frac{\partial in_{o1}}{\partial outp_2} + \frac{\partial E_{total}}{\partial in_{o2}} \cdot \frac{\partial in_{o2}}{\partial outp_2} \right) \cdot \frac{\partial outp_2}{\partial in_{p2}} = (coef_{o1} \cdot w_2 + coef_{o2} \cdot w_4) \cdot 1$

$= (-0.341 * 0.214 + 0.341 * 0.214) \cdot 1 = -0.146$

$coef_{c1} = \frac{\partial E_{total}}{\partial in_{c1}} = \frac{\partial E_{total}}{\partial in_{p1}} \cdot \frac{\partial in_{p1}}{\partial out_{c1}} \cdot \frac{\partial out_{c1}}{\partial in_{c1}} = coef_{p1} * w_{11} * 1 = -0.082 * 0 * 1 = 0$

$coef_{c2} = \frac{\partial E_{total}}{\partial in_{c2}} = \frac{\partial E_{total}}{\partial in_{p1}} \cdot \frac{\partial in_{p1}}{\partial out_{c2}} \cdot \frac{\partial out_{c2}}{\partial in_{c2}} = coef_{p1} * w_{12} * 1 = -0.082 * 1 * 1 = -0.082$

$coef_{c3} = \frac{\partial E_{total}}{\partial in_{c3}} = \left(\frac{\partial E_{total}}{\partial in_{p1}} \cdot \frac{\partial in_{p1}}{\partial out_{c3}} + \frac{\partial E_{total}}{\partial in_{p2}} \cdot \frac{\partial in_{p2}}{\partial out_{c3}} \right) \cdot \frac{\partial out_{c3}}{\partial in_{c3}} = (coef_{p1} * w_{13} + coef_{p2} * w_{23}) * 1$

$= (-0.082 * 0 + (-0.146) * 1) * 1 = -0.146$

$coef_{c4} = \frac{\partial E_{total}}{\partial in_{c4}} = \frac{\partial E_{total}}{\partial in_{p2}} \cdot \frac{\partial in_{p2}}{\partial out_{c4}} \cdot \frac{\partial out_{c4}}{\partial in_{c4}} = coef_{p2} * w_{24} * 1 = -0.146 * 0 * 1 = 0$

$k_{11} = k_{11} - \alpha \frac{\partial E_{total}}{\partial k_{11}} = k_{11} - \left(\frac{\partial E_{total}}{\partial in_{c1}} \cdot \frac{\partial in_{c1}}{\partial k_{11}} + \frac{E_{total}}{\partial in_{c1}} \cdot \frac{\partial in_{c1}}{\partial k_{11}} \right) * \alpha = k_{11} - \alpha (coef_{c1} \cdot i_1 + coef_{c1} \cdot 0)$

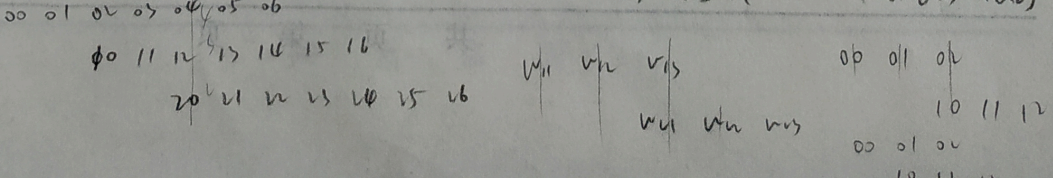
$= 0.1 - 0.5 * (0 * 0.2 + (-0.082) \cdot 0) = 0.1$

$k_{12} = k_{12} - \alpha \frac{\partial E_{total}}{\partial k_{12}} = k_{12} - \left(\frac{\partial E_{total}}{\partial in_{c1}} \cdot \frac{\partial in_{c1}}{\partial k_{12}} + \frac{\partial E_{total}}{\partial in_{c2}} \cdot \frac{\partial in_{c2}}{\partial k_{12}} \right) * \alpha = k_{12} - \alpha (coef_{c1} * i_1 + coef_{c2} * i_2)$

$= 0.2 - 0.5 * (0 * 0.1 + (-0.082) * 0.3) = 0.212$

$k_{13} = k_{13} - \alpha \frac{\partial E_{total}}{\partial k_{13}} = k_{13} - \left(\frac{\partial E_{total}}{\partial in_{c1}} \cdot \frac{\partial in_{c1}}{\partial k_{13}} + \frac{\partial E_{total}}{\partial in_{c2}} \cdot \frac{\partial in_{c2}}{\partial k_{13}} \right) * \alpha = k_{13} - \alpha (coef_{c1} * 0 + coef_{c2} * i_1)$

$= 0.3 - 0.5 * (0 * 0 + (-0.082) * 0.2) = 0.308$



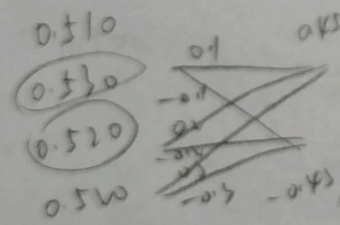
$$k_{11} = k_{11} - \alpha\left(\frac{\partial E_{m1}}{\partial in_{C3}} \cdot \frac{\partial in_{C3}}{\partial k_{11}} + \frac{\partial E_{m1}}{\partial in_{C4}} \cdot \frac{\partial in_{C4}}{\partial k_{11}}\right) = k_{11} - \alpha(coef_{C3} \cdot i_1 + coef_{C4} \cdot 0) =$$
$$= 0.3 - 0.5 \times (-0.146 \times 0.2 + 0 \times 0) = 0.315$$

$$k_{12} = k_{12} - \alpha\left(\frac{\partial E_{m1}}{\partial in_{C3}} \cdot \frac{\partial in_{C3}}{\partial k_{12}} + \frac{\partial E_{m1}}{\partial in_{C4}} \cdot \frac{\partial in_{C4}}{\partial k_{12}}\right) = k_{12} - \alpha(coef_{C3} \cdot i_1 + coef_{C4} \cdot i_1)$$
$$= 0.2 - 0.5 \times (-0.146 \times 0.1 + 0 \times 0.1) = 0.207$$

$$k_{13} = k_{13} - \alpha\left(\frac{\partial E_{m1}}{\partial in_{C3}} \cdot \frac{\partial in_{C3}}{\partial k_{13}} + \frac{\partial E_{m1}}{\partial in_{C4}} \cdot \frac{\partial in_{C4}}{\partial k_{13}}\right) = k_{13} - \alpha(coef_{C3} \cdot 0 + coef_{C4} \cdot i_1)$$
$$= 0.1 - 0.5 \times (-0.146 \times 0 + 0 \times 0.1) = 0.1$$

$$b_1 = b_1 - \alpha \frac{\partial E_{m1}}{\partial b_1} = b_1 - \alpha\left(\frac{\partial E_{m1}}{\partial in_{C3}} + \frac{\partial E_{m1}}{\partial in_{C4}}\right) \cdot 1 = b_1 - \alpha(coef_{C3} + coef_{C4}) = 0 - 0.5(0 + (-0.082))$$
$$= 0.041$$

$$b_2 = b_2 - \alpha \frac{\partial E_{m1}}{\partial b_2} = b_2 - \alpha\left(\frac{\partial E_{m1}}{\partial in_{C3}} + \frac{\partial E_{m1}}{\partial in_{C4}}\right) \cdot 1 = b_2 - \alpha(coef_{C3} + coef_{C4}) = 0 - 0.5(-0.146 + 0) = 0.073$$



$coef_{O1} = 0.714 - 1 = -0.286$

$coef_{O2} = 0.286 - 0 = 0.286$

$coef_{P1} = -0.286 \times 0.12$

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