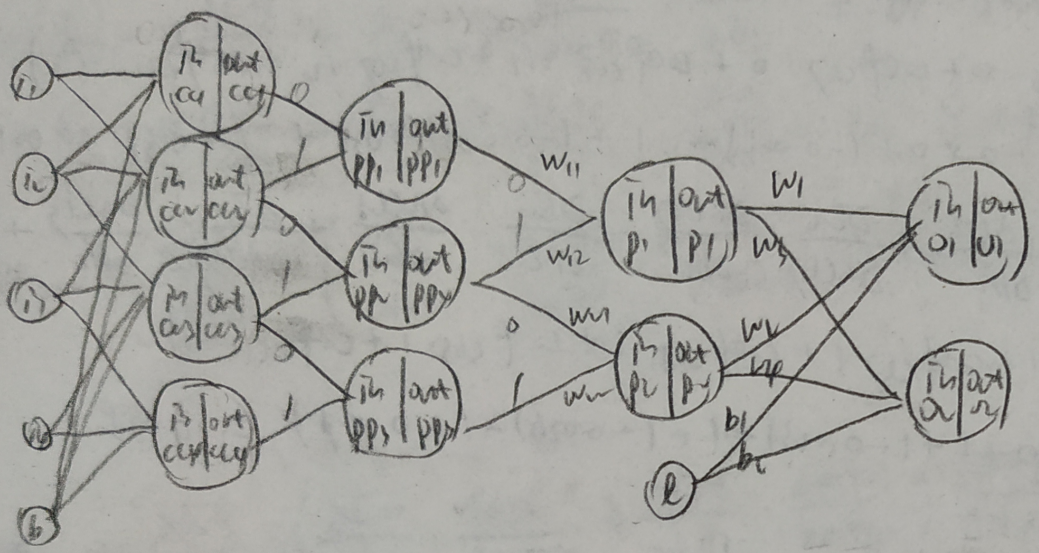
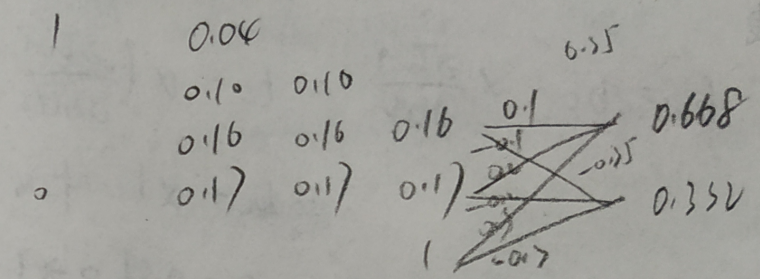




正向传播

$in_{pp_1} = max(i_1, i_2)$

$in_{pp_2} = max(i_2, i_3)$

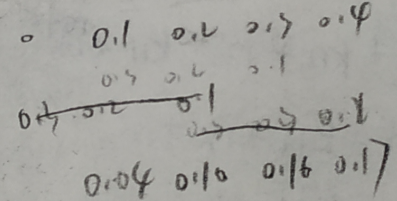
$in_{pp_3} = max(i_3, i_6)$

$in_{p_1} = max(out_{pp_1}, out_{pp_2})$

$in_{p_2} = max(out_{pp_2}, out_{pp_3})$

$in_{o_1} = w_1 \cdot out_{p_1} + w_2 \cdot out_{p_2} + b_1$

$in_{o_2} = w_3 \cdot out_{p_1} + w_4 \cdot out_{p_2} + b_2$



$in_{cc_1} = 0 * kk_{13} + i_1 * kk_{12} + i_2 * kk_{11} + b$

$in_{cc_2} = i_1 * kk_{13} + i_2 * kk_{12} + i_3 * kk_{11} + b$

$in_{cc_3} = i_2 * kk_{13} + i_3 * kk_{12} + i_4 * kk_{11} + b$

$in_{cc_4} = i_3 * kk_{13} + i_4 * kk_{12} + 0 * kk_{11} + b$

反向传播

$coef_{o1} = \frac{\partial E_{sum}}{\partial in_{o1}} = out_1 - o_1 = 0.668 - 1 = -0.332$

$coef_{o2} = \frac{\partial E_{sum}}{\partial in_{o2}} = out_2 - o_2 = 0.332 - 0 = 0.332$

$w_1 = w_1 - \alpha \frac{\partial E_{sum}}{\partial w_1} = w_1 - \alpha \frac{\partial E_{sum}}{\partial in_{o1}} \cdot \frac{\partial in_{o1}}{\partial w_1} = w_1 - \alpha \cdot coef_{o1} \cdot outp_1$

$= 0.1 - 0.5 * (-0.332) * 0.16 = 0.127$

$w_2 = w_2 - \alpha \frac{\partial E_{sum}}{\partial w_2} = w_2 - \alpha \frac{\partial E_{sum}}{\partial in_{o1}} \cdot \frac{\partial in_{o1}}{\partial w_2} = w_2 - \alpha \cdot coef_{o1} \cdot outp_2$

$= 0.2 - 0.5 * (-0.332) * 0.17 = 0.228$

$w_3 = w_3 - \alpha \frac{\partial E_{sum}}{\partial w_3} = w_3 - \alpha \frac{\partial E_{sum}}{\partial in_{o2}} \cdot \frac{\partial in_{o2}}{\partial w_3} = w_3 - \alpha \cdot coef_{o2} \cdot outp_1$

$= -0.1 - 0.5 * 0.332 * 0.16 = -0.127$

$w_4 = w_4 - \alpha \frac{\partial E_{sum}}{\partial w_4} = w_4 - \alpha \frac{\partial E_{sum}}{\partial in_{o2}} \cdot \frac{\partial in_{o2}}{\partial w_4} = w_4 - \alpha \cdot coef_{o2} \cdot outp_2$

$= -0.2 - 0.5 * 0.332 * 0.17 = -0.228$

$b_1 = b_1 - \alpha \frac{\partial E_{sum}}{\partial b_1} = b_1 - \alpha \frac{\partial E_{sum}}{\partial in_{o1}} \cdot \frac{\partial in_{o1}}{\partial b_1} = b_1 - \alpha \cdot coef_{o1} \cdot 1 = 0.5 - 0.5 * (-0.332) * 1 = 0.666$

$b_2 = b_2 - \alpha \frac{\partial E_{sum}}{\partial b_2} = b_2 - \alpha \frac{\partial E_{sum}}{\partial in_{o2}} \cdot \frac{\partial in_{o2}}{\partial b_2} = b_2 - \alpha coef_{o2} \cdot 1 = -0.5 - 0.5 * 0.332 * 1 = -0.666$

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

$= -0.332 * 0.127 + 0.332 * (-0.127)$

$= -0.084$

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

$= -0.332 * 0.228 + 0.332 * (-0.228) = -0.151$

$coef_{pp1} = \frac{\partial E_{sum}}{\partial in_{pp1}} = \frac{\partial E_{sum}}{\partial in_{p1}} \cdot \frac{\partial in_{p1}}{\partial outpp_1} \cdot \frac{\partial outpp_1}{\partial in_{pp1}} = coef_{p1} \cdot w_{11} \cdot 1 = -0.084 * 0 * 1 = 0$

$coef_{pp2} = \frac{\partial E_{sum}}{\partial in_{pp2}} = \left(\frac{\partial E_{sum}}{\partial in_{p1}} \cdot \frac{\partial in_{p1}}{\partial outpp_2} + \frac{\partial E_{sum}}{\partial in_{p2}} \cdot \frac{\partial in_{p2}}{\partial outpp_2} \right) \frac{\partial outpp_2}{\partial in_{pp2}} = (coef_{p1} \cdot w_{12} + coef_{p2} \cdot w_{21}) \cdot 1$

$= (-0.084 * 1 + (-0.151) * 0) \cdot 1 = -0.084$

$coef_{pp3} = \frac{\partial E_{sum}}{\partial in_{pp3}} = \frac{\partial E_{sum}}{\partial in_{p2}} \cdot \frac{\partial in_{p2}}{\partial outpp_3} \cdot \frac{\partial outpp_3}{\partial in_{pp3}} = coef_{p2} \cdot w_{22} \cdot 1 = -0.151 * (*1) = -0.151$

$coef_{p1}$ w_{11} w_{12} ○

$coef_{p2}$ ○ w_{21} w_{22}

○ >

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○ >

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$$coef_{cc1} = \frac{\partial E_{total}}{\partial in_{cc1}} = \frac{\partial E_{total}}{\partial in_{pp1}} \cdot \frac{\partial in_{pp1}}{\partial out_{cc1}} \cdot \frac{\partial out_{cc1}}{\partial in_{cc1}} = coef_{pp1} \cdot WW_{11} \cdot 1 = 0 * 0 * 1 = 0$$

$$coef_{cc2} = \frac{\partial E_{total}}{\partial in_{cc2}} = \left(\frac{\partial E_{total}}{\partial in_{pp1}} \cdot \frac{\partial in_{pp1}}{\partial out_{cc2}} + \frac{\partial E_{total}}{\partial in_{pp2}} \cdot \frac{\partial in_{pp2}}{\partial out_{cc2}}\right) \cdot \frac{\partial out_{cc2}}{\partial in_{cc2}} = (coef_{pp1} \cdot WW_{12} + coef_{pp2} \cdot WW_{21}) \cdot 1$$

$$= (0 * 1 + (-0.084) * 0) \cdot 1 = 0$$

$$coef_{cc3} = \frac{\partial E_{total}}{\partial in_{cc3}} = \left(\frac{\partial E_{total}}{\partial in_{pp2}} \cdot \frac{\partial in_{pp2}}{\partial out_{cc3}} + \frac{\partial E_{total}}{\partial in_{pp3}} \cdot \frac{\partial in_{pp3}}{\partial out_{cc3}}\right) \cdot \frac{\partial out_{cc3}}{\partial in_{cc3}} = (coef_{pp2} \cdot WW_{22} + coef_{pp3} \cdot WW_{31}) \cdot 1$$

$$= (-0.084 * 1 + (-0.151) * 0) * 1 = -0.084$$

$$coef_{cc4} = \frac{\partial E_{total}}{\partial in_{cc4}} = \frac{\partial E_{total}}{\partial in_{pp3}} \cdot \frac{\partial in_{pp3}}{\partial out_{cc4}} \cdot \frac{\partial out_{cc4}}{\partial in_{cc4}} = coef_{pp3} \cdot WW_{32} \cdot 1 = -0.151 * 1 * 1 = -0.151$$

$$KK_{11} = KK_{11} - \alpha \frac{\partial E_{total}}{\partial KK_{11}} = KK_{11} - \alpha\left(\frac{\partial E_{total}}{\partial in_{cc1}} \cdot \frac{\partial in_{cc1}}{\partial KK_{11}} + \frac{\partial E_{total}}{\partial in_{cc2}} \cdot \frac{\partial in_{cc2}}{\partial KK_{11}} + \frac{\partial E_{total}}{\partial in_{cc3}} \cdot \frac{\partial in_{cc3}}{\partial KK_{11}} + \frac{\partial E_{total}}{\partial in_{cc4}} \cdot \frac{\partial in_{cc4}}{\partial KK_{11}}\right)$$

$$= KK_{11} - \alpha(coef_{cc1} \cdot i_2 + coef_{cc2} \cdot i_3 + coef_{cc3} \cdot i_4 + coef_{cc4} \cdot 0)$$

$$= 0.1 - 0.5(0 * 0.2 + 0 * 0.3 + (-0.084) * 0.4 + (-0.151) * 0) = 0.117$$

$$KK_{12} = KK_{12} - \alpha \frac{\partial E_{total}}{\partial KK_{12}} = KK_{12} - \alpha\left(\frac{\partial E_{total}}{\partial in_{cc1}} \cdot \frac{\partial in_{cc1}}{\partial KK_{12}} + \frac{\partial E_{total}}{\partial in_{cc2}} \cdot \frac{\partial in_{cc2}}{\partial KK_{12}} + \frac{\partial E_{total}}{\partial in_{cc3}} \cdot \frac{\partial in_{cc3}}{\partial KK_{12}} + \frac{\partial E_{total}}{\partial in_{cc4}} \cdot \frac{\partial in_{cc4}}{\partial KK_{12}}\right)$$

$$= KK_{12} - \alpha(coef_{cc1} \cdot i_1 + coef_{cc2} \cdot i_2 + coef_{cc3} \cdot i_3 + coef_{cc4} \cdot i_4) =$$

$$= 0.2 - 0.5(0 * 0.1 + 0 * 0.2 + (-0.084) * 0.3 + (-0.151) * 0.4) = 0.243$$

$$KK_{13} = KK_{13} - \alpha \frac{\partial E_{total}}{\partial KK_{13}} = KK_{13} - \alpha\left(\frac{\partial E_{total}}{\partial in_{cc1}} \cdot \frac{\partial in_{cc1}}{\partial KK_{13}} + \frac{\partial E_{total}}{\partial in_{cc2}} \cdot \frac{\partial in_{cc2}}{\partial KK_{13}} + \frac{\partial E_{total}}{\partial in_{cc3}} \cdot \frac{\partial in_{cc3}}{\partial KK_{13}} + \frac{\partial E_{total}}{\partial in_{cc4}} \cdot \frac{\partial in_{cc4}}{\partial KK_{13}}\right)$$

$$= KK_{13} - \alpha(coef_{cc1} \cdot 0 + coef_{cc2} \cdot i_1 + coef_{cc3} \cdot i_2 + coef_{cc4} \cdot i_3)$$

$$= 0.3 - 0.5(0 * 0 + 0 * 0.1 + (-0.084) * 0.2 + (-0.151) * 0.3) = 0.331$$

$$b = b - \alpha \frac{\partial E_{total}}{\partial b} = b - \alpha\left(\frac{\partial E_{total}}{\partial in_{cc1}} \cdot \frac{\partial in_{cc1}}{\partial b} + \frac{\partial E_{total}}{\partial in_{cc2}} \cdot \frac{\partial in_{cc2}}{\partial b} + \frac{\partial E_{total}}{\partial in_{cc3}} \cdot \frac{\partial in_{cc3}}{\partial b} + \frac{\partial E_{total}}{\partial in_{cc4}} \cdot \frac{\partial in_{cc4}}{\partial b}\right)$$

$$= b - \alpha(coef_{cc1} \cdot 1 + coef_{cc2} \cdot 1 + coef_{cc3} \cdot 1 + coef_{cc4}$$

$$= 0 - 0.5(0 * 1 + 0 * 1 + (-0.084) * 1 + (-0.151) * 1) = 0.118$$