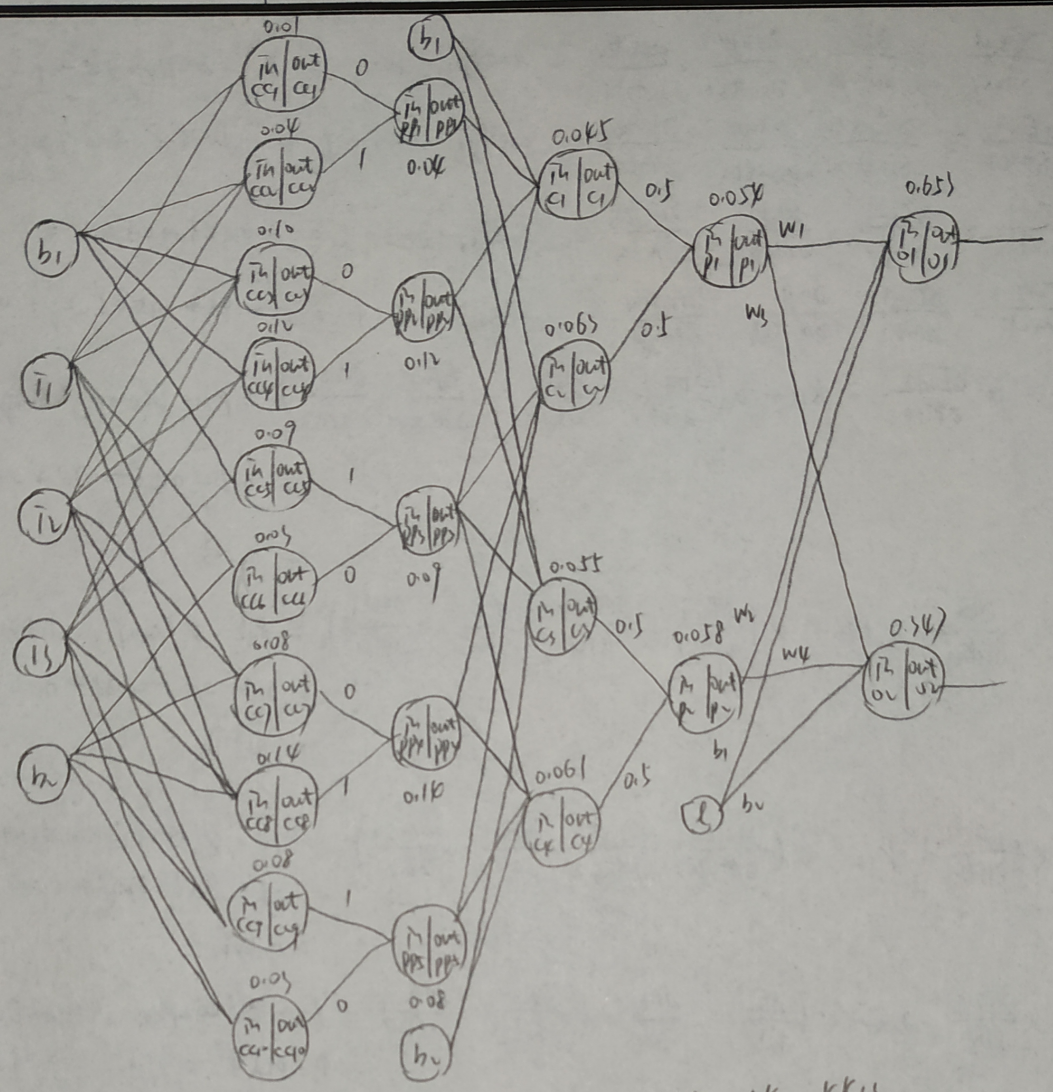
full max valid avg



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正向传播

$kk_{11}\ kk_{12}\ kk_{13}$

kk_1 (0.1 0.2 0.3 , 0)

$kk_{21}\ kk_{22}\ kk_{23}$

kk_2 (0.3 0.2 0.1 , 0)

$in_{cc1} = 0 * kk_{13} + 0 * kk_{12} + i_1 * kk_{11} + b_1$

$in_{cc2} = 0 * kk_{13} + i_1 * kk_{12} + i_2 * kk_{11} + b_1$

$in_{cc3} = i_1 * kk_{13} + i_2 * kk_{12} + i_3 * kk_{11} + b_1$

$in_{cc4} = i_2 * kk_{13} + i_3 * kk_{12} + 0 * kk_{11} + b_1$

$in_{cc5} = i_3 * kk_{13} + 0 * kk_{12} + 0 * kk_{11} + b_1$

$in_{cc6} = 0 * kk_{23} + 0 * kk_{22} + i_1 * kk_{21} + b_2$

$in_{cc7} = 0 * kk_{23} + i_1 * kk_{22} + i_2 * kk_{21} + b_2$

$in_{cc8} = i_1 * kk_{23} + i_2 * kk_{22} + i_3 * kk_{21} + b_2$

$in_{cc9} = i_2 * kk_{23} + i_3 * kk_{22} + 0 * kk_{21} + b_2$

$in_{cc10} = i_3 * kk_{23} + 0 * kk_{22} + 0 * kk_{21} + b_2$

$in_{pp1} = w_{11} \cdot out_{cc1} + w_{12} \cdot out_{cc2}$

$in_{pp2} = w_{21} \cdot out_{cc3} + w_{22} \cdot out_{cc4}$

$in_{pp3} = w_{31} \cdot out_{cc5} + w_{32} \cdot out_{cc6}$

$in_{pp4} = w_{41} \cdot out_{cc7} + w_{42} \cdot out_{cc8}$

$in_{pp5} = w_{51} \cdot out_{cc9} + w_{52} \cdot out_{cc10}$

$k_1 \begin{matrix} k_{11} & k_{12} & k_{13} \\ (0.1 & 0.2 & 0.3, 0) \end{matrix}$ $\quad k_2 \begin{matrix} k_{21} & k_{22} & k_{23} \\ (0.3 & 0.2 & 0.1, 0) \end{matrix}$

$in_{c1} = k_{13} \cdot out_{pp1} + k_{12} \cdot out_{pp2} + k_{11} \cdot out_{pp3} + b_1$

$in_{c2} = k_{13} \cdot out_{pp3} + k_{12} \cdot out_{pp4} + k_{11} \cdot out_{pp5} + b_1$

$in_{c3} = k_{23} \cdot out_{pp1} + k_{22} \cdot out_{pp2} + k_{21} \cdot out_{pp3} + b_2$

$in_{c4} = k_{23} \cdot out_{pp3} + k_{22} \cdot out_{pp4} + k_{21} \cdot out_{pp5} + b_2$

$in_{p1} = \frac{1}{2}(out_{c1} + out_{c2})$

$in_{p2} = \frac{1}{2}(out_{c3} + out_{c4})$

$in_{o1} = w_1 \cdot out_{p1} + w_2 \cdot out_{p2} + b_1$

$in_{o2} = w_3 \cdot out_{p3} + w_4 \cdot out_{p4} + b_2$

反向传播

$coef_{o1} = \frac{\partial E_{total}}{\partial in_{o1}} = out_1 - o_1 = 0.653 - 1 = -0.347$

$coef_{o2} = \frac{\partial E_{total}}{\partial in_{o2}} = out_2 - o_2 = 0.347 - 0 = 0.347$

$w_1 = w_1 - \alpha \frac{\partial E_{total}}{\partial w_1} = w_1 - \alpha \frac{\partial E_{total}}{\partial in_{o1}} \frac{\partial in_{o1}}{\partial w_1} = w_1 - \alpha \cdot coef_{o1} \cdot out_{p1} = 0.1 - 0.5 * (-0.347) * 0.054$
$= 0.109$

$w_2 = w_2 - \alpha \frac{\partial E_{total}}{\partial w_2} = w_2 - \alpha \frac{\partial in_{o1}}{\partial in_{o1}} \frac{\partial in_{o1}}{\partial w_2} = w_2 - \alpha \, coef_{o1} \cdot out_{p2} = 0.2 - 0.5 * (-0.347) * 0.058$
$= 0.210$

$w_3 = w_3 - \alpha \frac{\partial E_{total}}{\partial w_3} = w_3 - \alpha \frac{\partial E_{total}}{\partial in_{o2}} \cdot \frac{\partial in_{o2}}{\partial w_1} = w_3 - \alpha \cdot coef_{o2} \cdot out_{p1} = -0.1 - 0.5 * 0.347 * 0.054$
$= -0.109$

$w_4 = w_4 - \alpha \frac{\partial E_{total}}{\partial w_4} = w_4 - \alpha \frac{\partial E_{total}}{\partial in_{o2}} \cdot \frac{\partial in_{o2}}{\partial w_2} = w_4 - \alpha \cdot coef_{o2} \cdot out_{p2} = -0.2 - 0.5 * 0.347 * 0.058$
$= -0.210$

$b_1 = b_1 - \alpha \frac{\partial E_{total}}{\partial b_1} = b_1 - \alpha \frac{\partial E_{total}}{\partial in_{o1}} \cdot \frac{\partial in_{o1}}{\partial b_1} = b_1 - \alpha \cdot coef_{o1} \cdot 1 = 0 - 0.5 * (-0.347) = 0.174$

$b_2 = b_2 - \alpha \frac{\partial E_{total}}{\partial b_2} = b_2 - \alpha \frac{\partial E_{total}}{\partial in_{o2}} \cdot \frac{\partial in_{o2}}{\partial b_2} = b_2 - \alpha \cdot coef_{o2} \cdot 1 = 0 - 0.5 * 0.347 = -0.174$

$coef_{p1} = \frac{\partial E_{total}}{\partial in_{p1}} = \left(\frac{\partial E_{total}}{\partial in_{o1}} \cdot \frac{\partial in_{o1}}{\partial out_{p1}} + \frac{\partial E_{total}}{\partial in_{o2}} \cdot \frac{\partial in_{o2}}{\partial out_{p1}}\right) \frac{\partial out_{p1}}{\partial in_{p1}} = (coef_{o1} \cdot w_1 + coef_{o2} \cdot w_3) \cdot 1$
$= -0.347 * 0.109 + 0.347 * (-0.109) = -0.076$

$coef_{p2} = \frac{\partial E_{total}}{\partial in_{p2}} = \left(\frac{\partial E_{total}}{\partial in_{o1}} \cdot \frac{\partial in_{o1}}{\partial out_{p2}} + \frac{\partial E_{total}}{\partial in_{o2}} \cdot \frac{\partial in_{o2}}{\partial out_{p2}}\right) \cdot \frac{\partial out_{p2}}{\partial in_{p2}} = (coef_{o1} \cdot w_2 + coef_{o2} \cdot w_4) \cdot 1$
$= -0.347 * 0.210 + 0.347 * (-0.210) = -0.146$

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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$$coef_{c1} = \frac{\partial E_{tot}}{\partial in_{c1}} = \frac{\partial E_{tot}}{\partial out_{p1}} \cdot \frac{\partial in_{p1}}{\partial out_{c1}} \cdot \frac{\partial out_{c1}}{\partial in_{c1}} = coef_{p1} \cdot w_{11} \cdot 1 = -0.076 * 0.5 * 1 = -0.038$$

$$coef_{c2} = \frac{\partial E_{tot}}{\partial in_{c2}} = \frac{\partial E_{tot}}{\partial out_{p1}} \cdot \frac{\partial out_{p1}}{\partial in_{p1}} \cdot \frac{\partial out_{c1}}{\partial in_{c2}} = coef_{p1} \cdot w_{12} \cdot 1 = -0.076 * 0.5 * 1 = -0.038$$

$$coef_{c3} = \frac{\partial E_{tot}}{\partial in_{c3}} = \frac{\partial E_{tot}}{\partial out_{p2}} \cdot \frac{\partial out_{p2}}{\partial in_{p2}} \cdot \frac{\partial out_{c3}}{\partial in_{c3}} = coef_{p2} \cdot w_{21} \cdot 1 = -0.146 * 0.5 * 1 = -0.073$$

$$coef_{c4} = \frac{\partial E_{tot}}{\partial in_{c4}} = \frac{\partial E_{tot}}{\partial out_{p2}} \cdot \frac{\partial out_{p2}}{\partial in_{p2}} \cdot \frac{\partial out_{c4}}{\partial in_{c4}} = coef_{p2} \cdot w_{22} \cdot 1 = -0.146 * 0.5 * 1 = -0.073$$

$$k_{11} = k_{11} - \alpha \frac{\partial E_{tot}}{\partial k_{11}} = k_{11} - \alpha \left(\frac{\partial E_{tot}}{\partial in_{c1}} \cdot \frac{\partial in_{c1}}{\partial k_{11}} + \frac{\partial E_{tot}}{\partial in_{c2}} \cdot \frac{\partial in_{c2}}{\partial k_{11}} \right) = k_{11} - \alpha (coef_{c1} \cdot outpp_1 + coef_{c2} \cdot outpp_2)$$

$$= 0.1 - 0.5 (-0.038 * 0.09 + (-0.038) * 0.08)$$

$$= 0.103$$

$$k_{12} = k_{12} - \alpha \frac{\partial E_{tot}}{\partial k_{12}} = k_{12} - \alpha \left(\frac{\partial E_{tot}}{\partial in_{c1}} \cdot \frac{\partial in_{c1}}{\partial k_{12}} + \frac{\partial E_{tot}}{\partial in_{c2}} \cdot \frac{\partial in_{c2}}{\partial k_{12}} \right) = k_{12} - \alpha (coef_{c1} \cdot outpp_2 + coef_{c2} \cdot outpp_4)$$

$$= 0.2 - 0.5 (-0.038 * 0.12 + (-0.038) * 0.14)$$

$$= 0.205$$

$$k_{13} = k_{13} - \alpha \frac{\partial E_{tot}}{\partial k_{13}} = k_{13} - \alpha \left(\frac{\partial E_{tot}}{\partial in_{c1}} \cdot \frac{\partial in_{c1}}{\partial k_{13}} + \frac{\partial E_{tot}}{\partial in_{c2}} \cdot \frac{\partial in_{c2}}{\partial k_{13}} \right) = k_{13} - \alpha (coef_{c1} \cdot outpp_1 + coef_{c2} \cdot outpp_3)$$

$$= 0.3 - 0.5 (-0.038 * 0.04 + (-0.038) * 0.09)$$

$$= 0.302$$

$$b_1 = b_1 - \alpha \frac{\partial E_{tot}}{\partial b_1} = b_1 - \alpha \left(\frac{\partial E_{tot}}{\partial in_{c1}} \cdot \frac{\partial in_{c1}}{\partial b_1} + \frac{\partial E_{tot}}{\partial in_{c2}} \cdot \frac{\partial in_{c2}}{\partial b_1} \right) = b_1 - \alpha (coef_{c1} \cdot 1 + coef_{c2} \cdot 1)$$

$$= 10 - 0.5 (-0.038 + (-0.038)) = 0.038$$

$$k_{21} = k_{21} - \alpha \frac{\partial E_{tot}}{\partial k_{21}} = k_{21} - \alpha \left(\frac{\partial E_{tot}}{\partial in_{c3}} \cdot \frac{\partial in_{c3}}{\partial k_{21}} + \frac{\partial E_{tot}}{\partial in_{c4}} \cdot \frac{\partial in_{c4}}{\partial k_{21}} \right) = k_{21} - \alpha (coef_{c3} \cdot outpp_3 + coef_{c4} \cdot outpp_5)$$

$$= 0.3 - 0.5 (-0.073 * 0.09 + (-0.073) * 0.08)$$

$$= 0.306$$

$$k_{22} = k_{22} - \alpha \frac{\partial E_{tot}}{\partial k_{22}} = k_{22} - \alpha \left(\frac{\partial E_{tot}}{\partial in_{c3}} \cdot \frac{\partial in_{c3}}{\partial k_{22}} + \frac{\partial E_{tot}}{\partial in_{c4}} \cdot \frac{\partial in_{c4}}{\partial k_{22}} \right) = k_{22} - \alpha (coef_{c3} \cdot outpp_4 + coef_{c4} \cdot outpp_6)$$

$$= 0.2 - 0.5 (-0.073 * 0.12 + (-0.073) * 0.14)$$

$$= 0.209$$

$$k_{23} = k_{23} - \alpha \frac{\partial E_{tot}}{\partial k_{23}} = k_{23} - \alpha \left(\frac{\partial E_{tot}}{\partial in_{c3}} \cdot \frac{\partial in_{c3}}{\partial k_{23}} + \frac{\partial E_{tot}}{\partial in_{c4}} \cdot \frac{\partial in_{c4}}{\partial k_{23}} \right) = k_{23} - \alpha (coef_{c3} \cdot outpp_5 + coef_{c4} \cdot outpp_7)$$

$$= 0.1 - 0.5 (-0.073 * 0.04 + (-0.073) * 0.09)$$

$$= 0.105$$

$$b_2 = b_2 - \alpha \frac{\partial E_{tot}}{\partial b_2} = b_2 - \alpha \left(\frac{\partial E_{tot}}{\partial in_{c3}} \cdot \frac{\partial in_{c3}}{\partial b_2} + \frac{\partial E_{tot}}{\partial in_{c4}} \cdot \frac{\partial in_{c4}}{\partial b_2} \right) = b_2 - \alpha (coef_{c3} \cdot 1 + coef_{c4} \cdot 1)$$

$$= 0 - 0.5 (-0.073 + (-0.073)) = 0.073$$

$$coef_{pp1} = \frac{\partial E_{sm}}{\partial inp_{pp1}} = \left(\frac{\partial E_{sm}}{\partial in_{c1}} \cdot \frac{\partial in_{c1}}{\partial outpp_1} + \frac{\partial E_{sm}}{\partial in_{c3}} \cdot \frac{\partial in_{c3}}{\partial outpp_1}\right) \cdot \frac{\partial outpp_1}{\partial inp_{pp1}}$$

$$= (coef_{c1} \cdot k_{13} + coef_{c3} \cdot k_{23}) \cdot 1 = (-0.038) * 0.302 + (-0.073) * 0.105 = -0.019$$

$$coef_{pp2} = \frac{\partial E_{sm}}{\partial inp_{pp2}} = \left(\frac{\partial E_{sm}}{\partial in_{c1}} \cdot \frac{\partial in_{c1}}{\partial outpp_2} + \frac{\partial E_{sm}}{\partial in_{c2}} \cdot \frac{\partial in_{c2}}{\partial outpp_2}\right) \frac{\partial outpp_2}{\partial inpp_2}$$

$$= (coef_{c1} \cdot k_{12} + coef_{c2} \cdot k_{11}) \cdot 1 = (-0.038) * 0.105 + (-0.073) * 0.209 = -0.025$$

$$coef_{pp3} = \frac{\partial E_{sm}}{\partial inp_{pp3}} = \left(\frac{\partial E_{sm}}{\partial in_{c1}} \cdot \frac{\partial in_{c1}}{\partial outpp_3} + \frac{\partial E_{sm}}{\partial in_{c2}} \cdot \frac{\partial in_{c2}}{\partial outpp_3} + \frac{\partial E_{sm}}{\partial in_{c3}} \cdot \frac{\partial in_{c3}}{\partial outpp_3} + \frac{\partial E_{sm}}{\partial in_{c4}} \cdot \frac{\partial in_{c4}}{\partial outpp_3}\right) \cdot \frac{\partial outpp_3}{\partial inp_{pp3}}$$

$$= (coef_{c1} \cdot k_{11} + coef_{c2} \cdot k_{13} + coef_{c3} \cdot k_{21} + coef_{c4} \cdot k_{23}) \cdot 1$$

$$= (-0.038) * 0.105 + (-0.038) * 0.302 + (-0.073) * 0.306 + (-0.073) * 0.105 = -0.045$$

$$coef_{pp4} = \frac{\partial E_{sm}}{\partial inp_{pp4}} = \left(\frac{\partial E_{sm}}{\partial in_{c2}} \cdot \frac{\partial in_{c2}}{\partial outpp_4} + \frac{\partial E_{sm}}{\partial in_{c4}} \cdot \frac{\partial in_{c4}}{\partial outpp_4}\right) \frac{\partial outpp_4}{\partial inp_{pp4}}$$

$$= (coef_{c2} \cdot k_{12} + coef_{c4} \cdot k_{11}) \cdot 1 = (-0.038) * 0.105 + (-0.073) * 0.209 = -0.015$$

$$coef_{pp5} = \frac{\partial E_{sm}}{\partial inp_{pp5}} = \left(\frac{\partial E_{sm}}{\partial in_{c2}} \cdot \frac{\partial in_{c2}}{\partial outpp_5} + \frac{\partial E_{sm}}{\partial in_{c4}} \cdot \frac{\partial in_{c4}}{\partial outpp_5}\right) \frac{\partial outpp_5}{\partial inp_{pp5}}$$

$$= (coef_{c2} \cdot k_{11} + coef_{c4} \cdot k_{21}) \cdot 1 = (-0.038) * 0.105 + (-0.073) * 0.306 = -0.026$$

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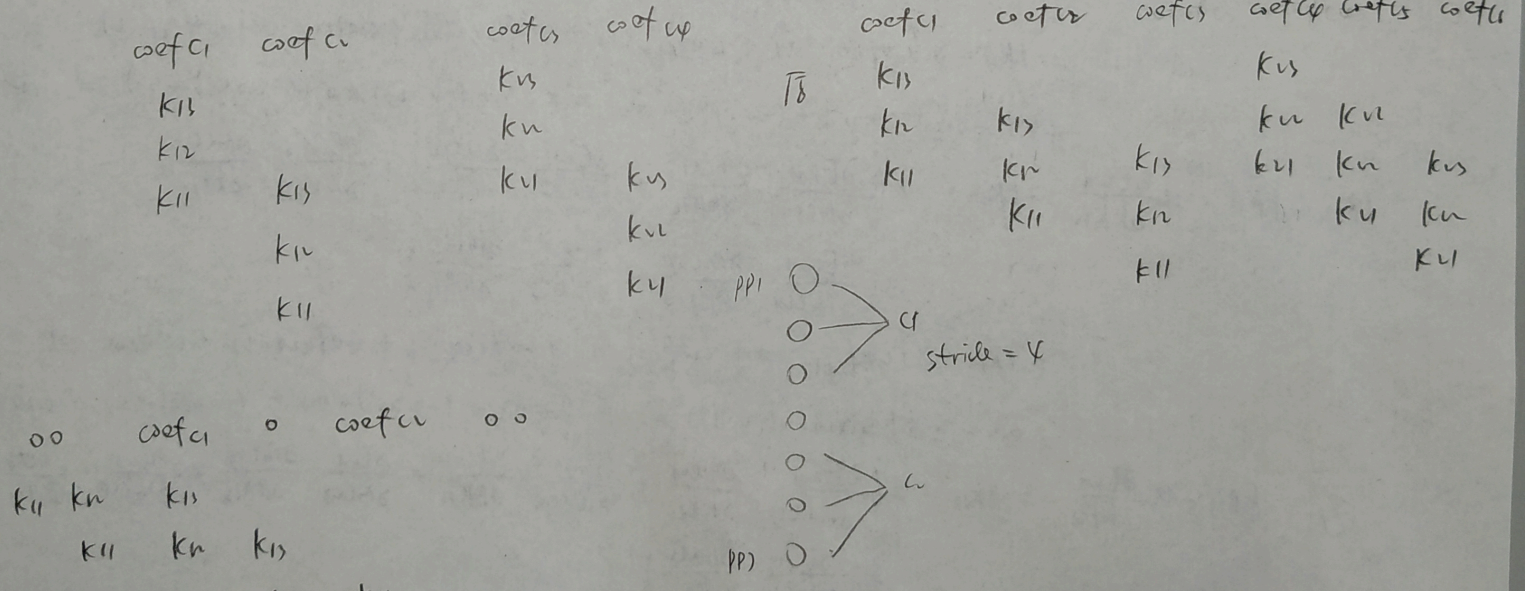
$2 + 6/2 - 1 \quad 2+5$



$2+5-1$
$2+6/2-1$

$7-3 \Rightarrow 5 \quad 3+n-1=7$
$n-1=6$
$n=3$

$coef_{cc1} = \frac{\partial E_{total}}{\partial in_{cc1}} = \frac{\partial E_{total}}{\partial in_{pp1}} \cdot \frac{\partial in_{pp1}}{\partial out_{cc1}} \cdot \frac{\partial out_{cc1}}{\partial in_{cc1}} = coef_{pp1} \cdot w_{11} \cdot 1 = -0.019 * 0 * 1 = 0$

$coef_{cc2} = \frac{\partial E_{total}}{\partial in_{cc2}} = \frac{\partial E_{total}}{\partial in_{pp1}} \cdot \frac{\partial in_{pp1}}{\partial out_{cc1}} \cdot \frac{\partial out_{cc1}}{\partial in_{cc2}} = coef_{pp1} \cdot w_{12} \cdot 1 = -0.019 * 1 * 1 = -0.019$

$coef_{cc3} = \frac{\partial E_{total}}{\partial in_{cc3}} = \frac{\partial E_{total}}{\partial in_{pp2}} \cdot \frac{\partial in_{pp2}}{\partial out_{cc3}} \cdot \frac{\partial out_{cc3}}{\partial in_{cc3}} = coef_{pp2} \cdot w_{21} \cdot 1 = -0.023 * 0 * 1 = 0$

$coef_{cc4} = \frac{\partial E_{total}}{\partial in_{cc4}} = \frac{\partial E_{total}}{\partial in_{pp2}} \cdot \frac{\partial in_{pp2}}{\partial out_{cc4}} \cdot \frac{\partial out_{cc4}}{\partial in_{cc4}} = coef_{pp2} \cdot w_{22} \cdot 1 = -0.023 * 1 * 1 = -0.023$

$coef_{cc5} = \frac{\partial E_{total}}{\partial in_{cc5}} = \frac{\partial E_{total}}{\partial in_{pp3}} \cdot \frac{\partial in_{pp3}}{\partial out_{cc5}} \cdot \frac{\partial out_{cc5}}{\partial in_{cc5}} = coef_{pp3} \cdot w_{31} \cdot 1 = -0.045 * 1 * 1 = -0.045$

$coef_{cc6} = \frac{\partial E_{total}}{\partial in_{cc6}} = \frac{\partial E_{total}}{\partial in_{pp3}} \cdot \frac{\partial in_{pp3}}{\partial out_{cc6}} \cdot \frac{\partial out_{cc6}}{\partial in_{cc6}} = coef_{pp3} \cdot w_{32} \cdot 1 = -0.045 * 0 * 1 = 0$

$coef_{cc7} = \frac{\partial E_{total}}{\partial in_{cc7}} = \frac{\partial E_{total}}{\partial in_{pp4}} \cdot \frac{\partial in_{pp4}}{\partial out_{cc7}} \cdot \frac{\partial out_{cc7}}{\partial in_{cc7}} = coef_{pp4} \cdot w_{41} \cdot 1 = -0.023 * 0 * 1 = 0$

$coef_{cc8} = \frac{\partial E_{total}}{\partial in_{cc8}} = \frac{\partial E_{total}}{\partial in_{pp4}} \cdot \frac{\partial in_{pp4}}{\partial out_{cc8}} \cdot \frac{\partial out_{cc8}}{\partial in_{cc8}} = coef_{pp4} \cdot w_{42} \cdot 1 = -0.023 * 1 * 1 = -0.023$

$coef_{cc9} = \frac{\partial E_{total}}{\partial in_{cc9}} = \frac{\partial E_{total}}{\partial in_{pp5}} \cdot \frac{\partial in_{pp5}}{\partial out_{cc9}} \cdot \frac{\partial out_{cc9}}{\partial in_{cc9}} = coef_{pp5} \cdot w_{51} \cdot 1 = -0.026 * 1 * 1 = -0.026$

$coef_{cc10} = \frac{\partial E_{total}}{\partial in_{cc10}} = \frac{\partial E_{total}}{\partial in_{pp5}} \cdot \frac{\partial in_{pp5}}{\partial out_{cc10}} \cdot \frac{\partial out_{cc10}}{\partial in_{cc10}} = coef_{pp5} \cdot w_{52} \cdot 1 = -0.026 * 0 * 1 = 0$

$kk_{11} = kk_{11} - \alpha \frac{\partial E_{total}}{\partial kk_{11}} = kk_{11} - \alpha \left(\frac{\partial E_{total}}{\partial in_{cc1}} \frac{\partial in_{cc1}}{\partial kk_{11}} + \frac{\partial E_{total}}{\partial in_{cc2}} \cdot \frac{\partial in_{cc2}}{\partial kk_{11}} + \frac{\partial E_{total}}{\partial in_{cc3}} \cdot \frac{\partial in_{cc3}}{\partial kk_{11}} + \frac{\partial E_{total}}{\partial in_{cc4}} \cdot \frac{\partial in_{cc4}}{\partial kk_{11}} + \frac{\partial E_{total}}{\partial in_{cc5}} \cdot \frac{\partial in_{cc5}}{\partial kk_{11}} \right)$

$= kk_{11} - \alpha (coef_{cc1} \cdot i_1 + coef_{cc2} \cdot i_2 + coef_{cc3} \cdot i_3 + coef_{cc4} \cdot 0 + coef_{cc5} \cdot 0)$

$= 0.1 - 0.5 (0 * 0.1 + (-0.019) * 0.2 + 0 * 0.3 + (-0.023) * 0 + (-0.045) * 0) = 0.1002$

$kk_{12} = kk_{12} - \alpha \frac{\partial E_{total}}{\partial kk_{12}} = kk_{12} - \alpha \left(\frac{\partial E_{total}}{\partial in_{cc1}} \cdot \frac{\partial in_{cc1}}{\partial kk_{12}} + \frac{\partial E_{total}}{\partial in_{cc2}} \cdot \frac{\partial in_{cc2}}{\partial kk_{12}} + \frac{\partial E_{total}}{\partial in_{cc3}} \cdot \frac{\partial in_{cc3}}{\partial kk_{12}} + \frac{\partial E_{total}}{\partial in_{cc4}} \cdot \frac{\partial in_{cc4}}{\partial kk_{12}} + \frac{\partial E_{total}}{\partial in_{cc5}} \cdot \frac{\partial in_{cc5}}{\partial kk_{12}} \right)$

$= kk_{12} - \alpha (coef_{cc1} \cdot 0 + coef_{cc2} \cdot i_1 + coef_{cc3} \cdot i_2 + coef_{cc4} \cdot i_3 + coef_{cc5} \cdot 0)$

$= 0.2 - 0.5 (0 * 0 + (-0.019) * 0.1 + 0 * 0.2 + (-0.023) * 0.3 + (-0.045) * 0) = 0.2049$

$kk_{13} = kk_{13} - \alpha \frac{\partial E_{total}}{\partial kk_{13}} = kk_{13} - \alpha \left(\frac{\partial E_{total}}{\partial in_{cc1}} \cdot \frac{\partial in_{cc1}}{\partial kk_{13}} + \frac{\partial E_{total}}{\partial in_{cc2}} \cdot \frac{\partial in_{cc2}}{\partial kk_{13}} + \frac{\partial E_{total}}{\partial in_{cc3}} \cdot \frac{\partial in_{cc3}}{\partial kk_{13}} + \frac{\partial E_{total}}{\partial in_{cc4}} \cdot \frac{\partial in_{cc4}}{\partial kk_{13}} + \frac{\partial E_{total}}{\partial in_{cc5}} \cdot \frac{\partial in_{cc5}}{\partial kk_{13}} \right)$

$= kk_{13} - \alpha (coef_{cc1} \cdot 0 + coef_{cc2} \cdot 0 + coef_{cc3} \cdot i_1 + coef_{cc4} \cdot i_2 + coef_{cc5} \cdot i_3)$

$= 0.3 - 0.5 (0 * 0 + (-0.019) * 0 + 0 * 0.1 + (-0.023) * 0.2 + (-0.045) * 0.3) = 0.3069$

$b_1 = b_1 - \alpha \frac{\partial E_{total}}{\partial b_1} = b_1 - \alpha \left(\frac{\partial E_{total}}{\partial in_{cc1}} \frac{\partial in_{cc1}}{\partial b_1} + \frac{\partial E_{total}}{\partial in_{cc2}} \cdot \frac{\partial in_{cc2}}{\partial b_1} + \frac{\partial E_{total}}{\partial in_{cc3}} \cdot \frac{\partial in_{cc3}}{\partial b_1} + \frac{\partial E_{total}}{\partial in_{cc4}} \cdot \frac{\partial in_{cc4}}{\partial b_1} + \frac{\partial E_{total}}{\partial in_{cc5}} \cdot \frac{\partial in_{cc5}}{\partial b_1} \right)$

$= 0 - 0.5 (0 * 1 + (-0.019) * 1 + 0 * 1 + (-0.023) * 1 + (-0.045) * 1) = 0.064$

$$kk_{21} = kk_{11} - \alpha \frac{\partial E_{11}}{\partial kk_{11}} = kk_{11} - \alpha\left(\frac{\partial E_{11}}{\partial in_{16}} \cdot \frac{\partial in_{16}}{\partial kk_{11}} + \frac{\partial E_{11}}{\partial in_{17}} \cdot \frac{\partial in_{17}}{\partial kk_{11}} + \frac{\partial E_{11}}{\partial in_{18}} \cdot \frac{\partial in_{18}}{\partial kk_{11}} + \frac{\partial E_{11}}{\partial in_{19}} \cdot \frac{\partial in_{19}}{\partial kk_{11}} + \frac{\partial E_{11}}{\partial in_{20}} \cdot \frac{\partial in_{20}}{\partial kk_{11}}\right)$$

$$= kk_{11} - \alpha(w_{16} \cdot i_1 + w_{17} \cdot i_2 + w_{18} \cdot i_3 + w_{19} \cdot 0 + w_{20} \cdot 0)$$

$$= 0.3 - 0.5(0*0.1 + 0*0.2 + (-0.015)*0.3 + (-0.026)*0 + 0*0) = 0.303$$

$$kk_{12} = kk_{12} - \alpha \frac{\partial E_{11}}{\partial kk_{12}} = kk_{12} - \alpha\left(\frac{\partial E_{11}}{\partial in_{16}} \cdot \frac{\partial in_{16}}{\partial kk_{12}} + \frac{\partial E_{11}}{\partial in_{17}} \cdot \frac{\partial in_{17}}{\partial kk_{12}} + \frac{\partial E_{11}}{\partial in_{18}} \cdot \frac{\partial in_{18}}{\partial kk_{12}} + \frac{\partial E_{11}}{\partial in_{19}} \cdot \frac{\partial in_{19}}{\partial kk_{12}} + \frac{\partial E_{11}}{\partial in_{20}} \cdot \frac{\partial in_{20}}{\partial kk_{12}}\right)$$

$$= kk_{12} - \alpha(w_{16} \cdot 0 + w_{17} \cdot i_1 + w_{18} \cdot i_2 + w_{19} \cdot i_3 + w_{20} \cdot 0)$$

$$= 0.2 - 0.5(0*0 + 0*0.1 + (-0.015)*0.2 + (-0.026)*0.3 + 0*0) = 0.206$$

$$kk_{13} = kk_{13} - \alpha \frac{\partial E_{11}}{\partial kk_{13}} = kk_{13} - \alpha\left(\frac{\partial E_{11}}{\partial in_{16}} \cdot \frac{\partial in_{16}}{\partial kk_{13}} + \frac{\partial E_{11}}{\partial in_{17}} \cdot \frac{\partial in_{17}}{\partial kk_{13}} + \frac{\partial E_{11}}{\partial in_{18}} \cdot \frac{\partial in_{18}}{\partial kk_{13}} + \frac{\partial E_{11}}{\partial in_{19}} \cdot \frac{\partial in_{19}}{\partial kk_{13}} + \frac{\partial E_{11}}{\partial in_{20}} \cdot \frac{\partial in_{20}}{\partial kk_{13}}\right)$$

$$= kk_{13} - \alpha(w_{16} \cdot 0 + w_{17} \cdot 0 + w_{18} \cdot i_1 + w_{19} \cdot i_2 + w_{20} \cdot i_3)$$

$$= 0.1 - 0.5(0*0 + 0*0 + (-0.015)*0.1 + (-0.026)*0.2 + 0*0.3) = 0.104$$

$$b_2 = b_2 - \alpha \frac{\partial E_{11}}{\partial b_2} = b_2 - \alpha\left(\frac{\partial E_{11}}{\partial in_{16}} \cdot \frac{\partial in_{16}}{\partial b_2} + \frac{\partial E_{11}}{\partial in_{17}} \cdot \frac{\partial in_{17}}{\partial b_2} + \frac{\partial E_{11}}{\partial in_{18}} \cdot \frac{\partial in_{18}}{\partial b_2} + \frac{\partial E_{11}}{\partial in_{19}} \cdot \frac{\partial in_{19}}{\partial b_2} + \frac{\partial E_{11}}{\partial in_{20}} \cdot \frac{\partial in_{20}}{\partial b_2}\right)$$

$$= b_2 - \alpha(w_{16} \cdot 1 + w_{17} \cdot 1 + w_{18} \cdot 1 + w_{19} \cdot 1 + w_{20} \cdot 1)$$

$$= 0 - 0.5(0*1 + 0*1 + (-0.015)*1 + (-0.026)*1 + 0*1) = 0.025$$

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