~~Backpropagation~~

w_5 $\frac{\partial E_{total}}{\partial w_5}$, $\frac{\partial E_{total}}{\partial w_6}$, $\frac{\partial E_{total}}{\partial w_7}$, $\frac{\partial E_{total}}{\partial w_8}$.

$E_{total} = E_{o1} + E_{o2}$ ~~$= \frac{1}{2}(target_{o1} - out_{o1})^2$~~

where $E_{o1} = \frac{1}{2}(target_{o1} - out_{o1})^2$

$out_{o1} = \frac{1}{1+e^{-net_{o1}}}$

$net_{o1} = w_5 * out_{h1} + w_6 * out_{h2} + b_2 * 1.$

$\therefore \frac{\partial E_{total}}{\partial w_5} = \frac{\partial E_{total}}{\partial out_{o1}} * \frac{\partial out_{o1}}{\partial net_{o1}} * \frac{\partial net_{o1}}{\partial w_5}$

again, $\frac{\partial E_{total}}{\partial out_{o1}} * \frac{\partial out_{o1}}{\partial net_{o1}} = \partial_1$

Now, we will find out the partial derivatives of

$\therefore E_{total} = \frac{1}{2}(target_{o1} - out_{o1})^2 + \frac{1}{2}(target_{o2} - out_{o2})^2$

$\therefore \boxed{\frac{\partial E_{total}}{\partial out_{o1}}} = 2 * \frac{1}{2}(target_{o1} - out_{o1}) * (-1) + 0$

$= -(target_{o1} - out_{o1})$

$= -(.01 - .75136)$

$= \boxed{.7413.}$

again, $out_{o1} = \frac{1}{1+e^{-net_{o1}}}$ $\frac{\partial out_{o1}}{\partial net_{o1}} = out_{o1}(1 - out_{o1})$

$= .75136 * (1 - .75136)$

$= .1868.$

Now. $net_{o1} = w_5 * out_{h1} + w_6 * out_{h2} + b_2 * 1.$

$\frac{\partial net_{o1}}{\partial w_5} = out_{h1} = .59326$

$\therefore \frac{\partial E_{total}}{\partial w_5} = .7413 * .1868 * .59326$

$= .0821$

$\therefore w_5^+ = w_5 - \eta * \frac{\partial E_{total}}{\partial w_5} = 0.4 - 0.5 * 0.082147$

$= .35891.$

w_6:

$$\frac{\partial E_{total}}{\partial w_6} = \frac{\partial E_{total}}{\partial out_{o1}} * \frac{\partial out_{o1}}{\partial net_{o1}} * \frac{\partial net_{o1}}{\partial w_6}$$

where,

$$\frac{\partial E_{total}}{\partial out_{o1}} * \frac{\partial out_{o1}}{\partial net_{o1}} = \partial o1$$

(1) $E_{total} = E_{o1} + E_{o2}$ where

$$E_{o1} = \frac{1}{2}(target_{o1} - out_{o1})^2$$

(2) $out_{o1} = \frac{1}{1+e^{-net_{o1}}}$

(3) $net_{o1} = w_5 * out_{h_1} + \boxed{w_6 * out_{h_2}} * b * 1$

$$\therefore \frac{\partial E_{total}}{\partial out_{o1}} = \cdot 74136507 * \cdot 1868 * \boxed{\frac{\partial net_{o1}}{\partial w_6}}$$

$$\therefore \frac{\partial net_{o1}}{\partial w_6} = w_5 * out_{h_1} + w_6 * out_{h_2} + b * 1$$

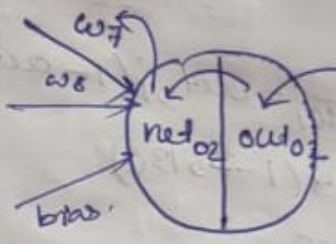
$$= out_{h_2} = \cdot 59688$$

$$\therefore w_6^+ = w_6 - \eta \frac{\partial E_{total}}{\partial w_6}$$

$$= \cdot 45 - \cdot 5 * [\cdot 74136507 * \cdot 1868 * \cdot 59688]$$

$$= \cdot 4086618$$

w_7:



$$E_{o2} = \frac{1}{2}(target_{o2} - out_{o2})^2$$

$$E_{total} = E_{o1} + E_{o2}$$

$$\therefore \frac{\partial E_{total}}{\partial w_7} = \frac{\partial E_{total}}{\partial out_{o2}} * \frac{\partial out_{o2}}{\partial net_{o2}} * \frac{\partial net_{o2}}{\partial w_7}$$

where,

$$\frac{\partial E_{total}}{\partial out_{o2}} * \frac{\partial out_{o2}}{\partial net_{o2}} = \partial_{o2}$$

(1) $\frac{\partial E_{total}}{\partial out_{o2}} = 0 + 2 * \frac{1}{2}(target_{o2} - out_{o2}) * -1$

$$= -(target_{o2} - out_{o2})$$

$$= -(\cdot 99 - \cdot 772928) = -\cdot 2170.$$

$out_{o2} = \frac{1}{1+e^{-net_{o2}}}$

$\therefore \frac{\partial out_{o2}}{\partial net_{o2}} = out_{o2}(1 - out_{o2})$

$= .772928(1 - .772928)$

$= .1755.$

3) $\frac{\partial net_{o2}}{\partial w_7} = w_7 * out_{h_1} + w_8 * out_{h_2} * b * .60$

$= out_{h_1} = .59326$

$\frac{\partial E_{total}}{\partial w_7} = -.2170 * .1755 * .59326$

$= -0.022593$

$\therefore w_7^+ = w_7 - \eta \frac{\partial E_{total}}{\partial w_7}$

$= .50 - .5 * (-0.022593)$

$= .511301 2.$

$\frac{\partial E_{total}}{\partial w_8} = \frac{\partial E_{total}}{\partial out_{o2}} * \frac{\partial out_{o2}}{\partial net_{o2}} * \frac{\partial net_{o2}}{\partial w_8}.$

1) $\frac{\partial E_{total}}{\partial out_{o2}}$ and $\frac{\partial out_{o2}}{\partial net_{o2}}$ will be same as before

But

$\frac{\partial net_{o2}}{\partial w_8} = w_7 * out_{h_1} + w_8 * out_{h_2} * b * 1$

$= out_{h_2}$

$= .59688$

$\therefore \frac{\partial E_{total}}{\partial w_8} = -.2170 * .1755 * .59688$

$= -.022731279$

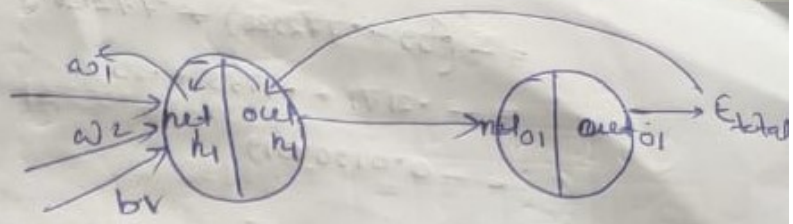
$\therefore w_8^+ = w_8 - \eta \frac{\partial E_{total}}{\partial w_8} = .55 - .5 * (-.022731279)$

$= .55 + .0113656$

$= .561365.$

$w_2 \; w_3 \; \& \; w_4$

Backpropagation



$$\frac{\partial E_{total}}{\partial w_1} = \frac{\partial E_{total}}{\partial out_{h_1}} * \frac{\partial out_{h_1}}{\partial net_{h_1}} * \frac{\partial net_{h_1}}{\partial w_1}$$

But, $\frac{\partial E_{total}}{\partial out_{h_1}} = \left(\frac{\partial E_{o_1}}{\partial out_{h_1}}\right) + \frac{\partial E_{o_2}}{\partial out_{h_1}}$

$E_{o_1} = \frac{1}{2}(target_{o_1} - out_{o_1})^2$

$out_{o_1} = \frac{1}{1+e^{-net_{o_1}}}$

$net_{o_1} = w_5 * out_{h_1} + w_6 * out_{h_2} + b_2 * 1$

$$\therefore \frac{\partial E_{o_1}}{\partial out_{h_1}} = \frac{\partial E_{o_1}}{\partial out_{o_1}} * \frac{\partial out_{o_1}}{\partial net_{o_1}} * \frac{\partial net_{o_1}}{\partial out_{h_1}}$$

Now, $\frac{\partial E_{o_1}}{\partial out_{o_1}} = \left[2 * \frac{1}{2}(target_{o_1} - out_{o_1}) * -1\right]$

$= -(target_{o_1} - out_{o_1})$

$= -(0.01 - .75136)$

$= .7413$

$\frac{\partial out_{o_1}}{\partial net_{o_1}} = out_{o_1}(1 - out_{o_1}) = .1868$

$\frac{\partial net_{o_1}}{\partial out_{h_1}} = w_5 = .40$

$$\therefore \frac{\partial E_{o_1}}{\partial out_{h_1}} = .7413 * .1868 * .40 = .05538$$

Now, ~~$\frac{\partial E_{o_2}}{\partial out_{h_1}} = \frac{\partial E_{o_2}}{\partial out_{o_2}} * \frac{\partial out_{o_2}}{\partial net_{o_2}}$~~

$E_{o_2} = \frac{1}{2}(target_{o_2} - out_{o_2})^2$

$out_{o_2} = \frac{1}{1+e^{-net_{o_2}}}$

$net_{o_2} = w_7 * out_{h_1} + w_8 * out_{h_2} * 1 * b_2$

$$\therefore \frac{\partial E_{o_2}}{\partial out_{h_1}} = \frac{\partial E_{o_2}}{\partial out_{o_2}} * \frac{\partial out_{o_2}}{\partial net_{o_2}} * \frac{\partial net_{o_2}}{\partial out_{h_1}}$$

$= -(target_{o_2} - out_{o_2}) * out_{o_2}(1 - out_{o_2}) * w_7$

$= -(.99 - .772928) * .772928 (1 - .772928) * .50$

$= -.2171 * .1755 * .50$

$= -0.01904919$

$\therefore \frac{\partial E_{total}}{\partial out_{h1}} = \frac{\partial E_{o1}}{\partial out_{h1}} + \frac{\partial E_{o2}}{\partial out_{h1}} = .055399 + (-0.090419)$

$= 0.03635$

$\rightarrow out_{h1}(1 - out_{h1})$

$= .2413007$

$\therefore \frac{\partial E_{total}}{\partial w_1} = \frac{\partial E_{total}}{\partial out_{h1}} * \frac{\partial out_{h1}}{\partial net_{h1}} * \frac{\partial net_{h1}}{\partial w_1}$

$= .03635 * (.1868) * \left[\frac{w_1 * i_1 + w_3 * i_2 + b_1 * 1}{\partial w_1}\right]$

$= .03635 * .2413007 * .005$

$= .0004385$

$\therefore w_1^+ = w_1 - \eta . \frac{\partial E_{total}}{\partial w_1}$

$= .15 - .5 * .0004385$

$= .14978071 6.$

~~Hey~~ w_2

$\frac{\partial E_{total}}{\partial w_2} = \frac{\partial E_{total}}{\partial out_{h1}} * \frac{\partial out_{h1}}{\partial net_{h1}} * \frac{\partial net_{h1}}{\partial w_2}$

$= .03635 * .2413007 * i_2$

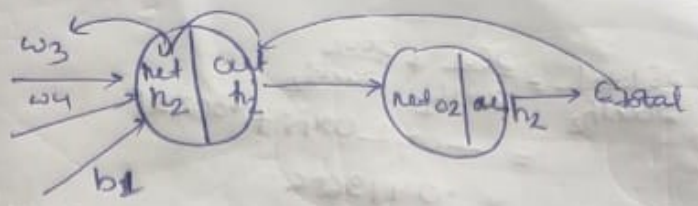
$= .03635 * .2413007 * .10$

$= .000877$

$\therefore w_2^+ = w_2 - .5 * .000877$

$= .20 - .000438$

$= .1995614$



$$\frac{\partial E_{total}}{\partial w_3} = \frac{\partial E_{total}}{\partial out_{h_2}} * \frac{\partial out_{h_2}}{\partial net_{h_2}} * \frac{\partial net_{h_2}}{\partial w_3}$$

But, $\frac{\partial E_{total}}{\partial out_{h_2}} = \frac{\partial E_{o1}}{\partial out_{h_2}} + \frac{\partial E_{o2}}{\partial out_{h_2}}$

$$E_{o2} = \frac{1}{2}(target_{o2} - out_{o2})^2$$

$$out_{o2} = \frac{1}{1+e^{-net_{o2}}}$$

$$net_{o2} = w_7 * out_{h_1} + w_8 * out_{h_2} * .60 \times 1$$

$$\therefore \frac{\partial E_{o2}}{\partial out_{h_2}} = \frac{\partial E_{o2}}{\partial out_{o2}} * \frac{\partial out_{o2}}{\partial net_{o2}} * \frac{\partial net_{o2}}{\partial out_{h_2}}$$

$$\therefore \frac{\partial E_{o2}}{\partial out_{o2}} = \left[2 \times \frac{1}{2}(target_{o2} - out_{o2})\right] * -1$$

$$= -(target_{o2} - out_{o2})$$

$$= -(.99 - .772928) = -.2170$$

$$\frac{\partial out_{o2}}{\partial net_{o2}} = out_{o2}(1 - out_{o2})$$

$$= .772928\,(1 - .772928)$$

$$= .1755$$

$$\frac{\partial net_{o2}}{\partial out_{h_2}} = w_8$$

$$= .55$$

$$\therefore \frac{\partial E_{o2}}{\partial out_{h_2}} = -.2170 * .1755 * .55$$

$$= -0.020945$$

Now, $E_{o1} = \frac{1}{2}(target_{o1} - out_{o1})^2$

$$out_{o1} = \frac{1}{1+e^{-net_{o1}}}$$

$$net_{o1} = w_5 * out_{h_1} + w_6 * out_{h_2} + b_2 \times 1$$

$$\therefore \frac{\partial E_{o1}}{\partial out_{h_2}} = \frac{\partial E_{o1}}{\partial out_{o1}} * \frac{\partial out_{o1}}{\partial net_{o1}} * \frac{\partial net_{o1}}{\partial out_{h_2}}$$

$$= -(target_{o1} - out_{o1}) * out_{o1}(1 - out_{o1}) * w_6$$

$$= .7413 * .1868 * .45 = 0.06231$$

$$\frac{\partial E_{total}}{\partial out_{h_2}} = \frac{\partial E_{o1}}{\partial out_{h_2}} + \frac{\partial E_{o2}}{\partial out_{h_2}}$$

$$= -0.02\,0945 + 0.0231$$

$$= 0.0413686$$

$$\frac{\partial E_{total}}{\partial w_3} = \frac{\partial E_{total}}{\partial out_{h_2}} * \frac{\partial out_{h_2}}{\partial net_{h_2}} * \frac{\partial net_{h_2}}{\partial w_3}$$

$$= 0.0413686 * 0.1755 * 0$$

$$= 0.0413686 * out_{h_2}(1 - out_{h_2}) * i_1$$

$$= 0.0413686 * 0.59688(1 - 0.59688) * 0.05$$

$$= 0.00049793$$

$$w_3^+ = w_3 - \eta \frac{\partial E_{total}}{\partial w_3}$$

$$= 0.25 - 0.5 * 0.00049793$$

$$= 0.24975$$

w_4 =?

$$\frac{\partial E_{total}}{\partial w_4} = \frac{\partial E_{total}}{\partial out_{h_2}} * \frac{\partial out_{h_2}}{\partial net_{h_2}} * \frac{\partial net_{h_2}}{\partial w_4}$$

$$= 0.0413686 * 0.240614 * i_2$$

$$= 0.0413686 * 0.240614 * 0.10$$

$$= 0.00099538$$

$$\therefore w_4^+ = w_4 - 0.5 * 0.00099538$$

$$= 0.30 - 0.00049793$$

$$= 0.29950207.$$