Forward Propagation

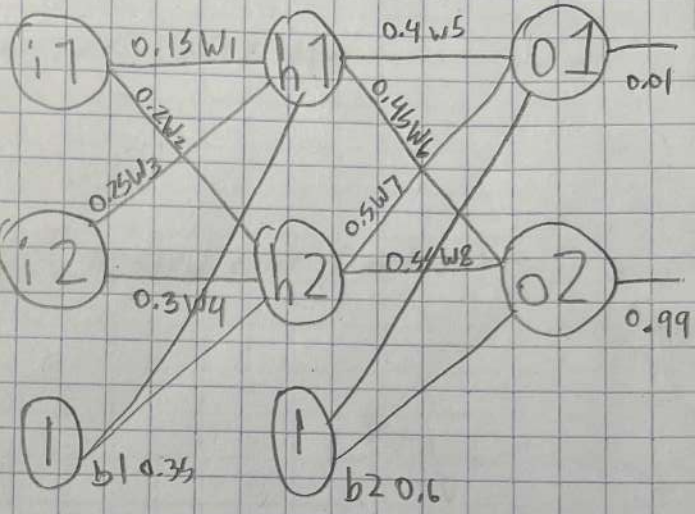
$net_{h1} = W_1 i_1 + W_2 i_2 + b_1 \times 1$

$= 0.15 \cdot 0.05 + 0.2 \cdot 0.1 + 0.35 \cdot 1$

$\boxed{net_{h1} = 0.3775}$

$Out_{h1} = \frac{1}{1+e^{-x}} = \frac{1}{1+e^{-0.3775}}$

$\boxed{Out_{h1} = 0.593269992}$



$net_{h2} = W_3 i_1 + W_4 i_2 + b_1 \times 1$

$= 0.25 \cdot 0.05 + 0.3 \cdot 0.1 + 0.35 \cdot 1$

$\boxed{net_{h2} = 0.3925}$

$Out_{h2} = \frac{1}{1+e^{-0.3925}}$

$\boxed{Out_{h2} = 0.596884378}$

$net_{o1} = W_5 (Out_{h1}) + W_6 (Out_{h2}) + b_2 \times 1$

$= 0.4 (0.593269992) + 0.45 (0.596884378) + 0.6 \times 1$

$\boxed{net_{o1} = 1.105905967}$

$Out_{o1} = \frac{1}{1+e^{-1.105905967}} = \frac{1}{1+0.330910951997}$

$\boxed{Out_{o1} = 0.751365077}$

$$net_{o2} = W_7(Out_{h1}) + W8(Out_{h2}) + b_2 \times 1$$
$$= 0.5(0.593269992) + 0.55(0.596884378) + 0.6 \times 1$$

$$\boxed{net_{o2} = 1.224921404}$$

$$Out_{o2} = \frac{1}{1+e^{-1.224921404}} = \frac{1}{1+0.293780789 44}$$

$$\boxed{Out_{o2} = 0.772928465}$$

Step 2: Calculating the total error (Squared error function)

$$E_{total} = \sum \frac{1}{2}(target - output)^2$$

$$E_{o1} = \frac{1}{2}(0.01 - 0.75136507)^2$$

$$\boxed{E_{o1} = 0.274811083}$$

$$E_{o2} = \frac{1}{2}(0.99 - 0.772928465)^2$$

$$\boxed{E_{o2} = 0.023560026}$$

∴ The total error for the NN is:

$$E_{total} = E_{o1} + E_{o2}$$
$$= 0.274811083 + 0.023560026$$

$$\boxed{E_{total} = 0.298371109}$$

Backward Propagation

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

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

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

$$= -(0.99 - 0.772928465)$$

$$\boxed{\frac{\partial E_{total}}{\partial E_{o2}} = -0.217071535}$$

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

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

$$= 0.772928465(1 - 0.772928465)$$

$$\boxed{= 0.175510052993}$$

$$\frac{\partial net_{o2}}{\partial w_7} = \frac{\partial}{\partial w_7}(w_7 \cdot out_{h1}) + \frac{\partial}{\partial w_7}(w_8 \cdot out_{h2}) + \frac{\partial}{\partial w_7}(b_2)$$

$$= out_{h1} \cdot \frac{\partial w_7}{\partial w_7} + 0 + 0$$

$$= out_{h1} \times 1$$

$$\boxed{= 0.593269992}$$

$$\frac{\partial E_{total}}{\partial w_7} = -0.217071535 \times 0.175510052993 \times 0.593269992$$

$$\boxed{= -0.022602540295}$$

$$W_{new} = W_{old} - \alpha * \frac{\partial E_{total}}{\partial W_{old}}$$

$$W_7 = W_7 - \alpha * \frac{\partial E_{total}}{\partial W_7}$$

$$= 0.5 - 0.5 * -0.022602540529 5$$

$$\boxed{W_{7_{new}} = 0.511301270265}$$

$$\frac{\partial E_{total}}{\partial W_3} = \frac{\partial E_{total}}{\partial out_{h2}} \times \frac{\partial out_{h2}}{\partial net_{h2}} \times \frac{\partial net_{h2}}{\partial W_3}$$

$$\frac{\partial E_{total}}{\partial out_{h2}} = \frac{\partial E_{o1}}{\partial out_{h2}} + \frac{\partial E_{o2}}{\partial out_{h2}}$$

$$\frac{\partial E_{o1}}{\partial out_{h2}} = \frac{\partial E_{o1}}{\partial net_{o1}} \times \frac{\partial net_{o1}}{\partial out_{h2}}$$

$$\frac{\partial E_{o1}}{\partial net_{o1}} = \frac{\partial E_{o1}}{\partial out_{o1}} \times \frac{\partial out_{o1}}{\partial net_{o1}}$$

$$= \frac{\partial}{\partial out_{o1}} \left[\frac{1}{2} (target_{o1} - out_{o1})^2 \right] \times 0.186815602$$

$$= \cancel{2} \times \frac{1}{\cancel{2}} (target_{o1} - out_{o1}) \times \frac{\partial}{\partial out_{o1}} (target_{o1} - out_{o1}) \times 0.186815602$$

$$= (target_{o1} - out_{o1}) \times (0-1) \times 0.186815602$$

$$\frac{\partial E_{o1}}{\partial net_{o1}} = 0.741365 07 \times 0.186815602$$

$$\boxed{= 0.138498562}$$

$$\frac{\partial net_{o1}}{\partial out_{h2}} = \frac{\partial}{\partial out_{h2}}\left(w_5(out_{h1}) + w_6(out_{h2}) + b_2 \times 1\right)$$

$$= 0 + w_6 * 1 + 0$$

$$\boxed{= w_6 = 0.45}$$

$$\therefore \frac{\partial E_{o1}}{\partial out_{h2}} = 0.138498562 \times 0.45$$

$$\boxed{= 0.062324353529}$$

$$\frac{\partial E_{o2}}{\partial out_{h2}} = \frac{\partial E_{o2}}{\partial out_{o2}} \times \frac{\partial out_{o2}}{\partial net_{o2}} \times \frac{\partial net_{o2}}{\partial out_{h2}}$$

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

$$* \frac{\partial}{\partial out_{h2}}\left(w_7(out_{h1}) + w_8(out_{h2}) + b_2 \times 1\right)$$

$$= \cancel{2} \times \frac{1}{\cancel{2}}(target_{o2} - out_{o2}) * (0 - 1)$$

$$= -(target_{o2} - out_{o2}) * out_{o2}(1 - out_{o2}) * w_8$$

$$= -(0.99 - 0.772928465) * 0.772928465(1 - 0.772928465) * 0.55$$

$$= -0.217071533 \times 0.175510053 \times 0.55$$

$$\boxed{= -0.020954029439}$$

$$\therefore \frac{\partial E_{total}}{\partial E_{out_{h2}}} = \frac{\partial E_{o1}}{\partial out_{h2}} + \frac{\partial E_{o2}}{\partial out_{h2}}$$

$$= 0.062324353529 + -0.020954029949439$$

$$\boxed{= 0.041370322956}$$

$$\frac{\partial out_{h2}}{\partial net_{h2}}$$

$$\left[f(x) = \frac{1}{1+e^{-x}} \qquad f'(x) = f(x)(1-f(x)) \right]$$

$$\frac{\partial}{\partial net_{h2}} \left(\frac{1}{1+e^{-net_{h2}}} \right)$$

$$\frac{\partial out_{h2}}{\partial net_{h2}} = out_{h2}(1-out_{h2}) = 0.596884378\,(1-0.596884378)$$

$$\boxed{= 0.240613473}$$

$$\frac{\partial net_{h2}}{\partial w_3}$$

$$\frac{\partial net_{h2}}{\partial w_3} = \frac{\partial}{\partial w_3} (w_3 i_1 + w_4 i_2 + b_1 \times 1)$$

$$= i_1 \times 1 + 0 + 0$$

$$\boxed{= i_1 = 0.5}$$

$$\frac{\partial E_{total}}{\partial W_3} = \frac{\partial E_{total}}{\partial out_{h2}} \times \frac{\partial out_{h2}}{\partial net_{h2}} \times \frac{\partial net_{h2}}{\partial W_3}$$

$$= 0.041370322956 1 \times 0.240613417 3 \times 0.5$$

$$= 0.000497712739064$$

$$W_{new} = W_{old} - \alpha * \frac{\partial E_{total}}{\partial W_{old}}$$

$$W_{3new} = 0.25 - 0.5 * 0,000497712739064$$

$$W_{3new} = 0,249751143 63$$