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Course Deep learning

Class MSDS

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Forward pass

Calculating $H_1$

Formula $H_1 = I_1 * W_1 + I_2 * W_2 + b_1$

$I_1 = 10 \quad I_2 = 20 \quad b_1 = 0.5$

$H_1 = 10 * 0.3 + 20 * 0.2 + 0.5$

$3 + 4 + 0.5 = 7.5$

Applying sigmoid function

$$H_1 = \frac{1}{1+e^{-7.5}} \Rightarrow \frac{1}{1+(2.718)^{-7.5}}$$

$$= \frac{1}{1.00055351}$$

$$\boxed{H_1 = 0.99944}$$

Calculating:- $H_2$

$H_2 = I_1 * W_3 + I_2 * W_4 + b_1$

$H_2 = 10 * (-0.1) + 20 * (-0.2) + 0.5$

$(-1) + (-4) + 0.5 = \boxed{-4.5}$

Calculating $H_2$ with sigmoid

$$H_2 = \frac{1}{1+e^{-(-4.5)}}$$

$$H_2 = \frac{1}{1+(2.718)^{4.5}}$$

$$H_2 = \frac{1}{1+(89.975} \Rightarrow \frac{1}{99.975}$$

$$\boxed{H_2 = 0.01000}$$

Calculating $H_3$

$H_3 = I_1 * W_5 + I_2 * W_6 + b_1$

$= 10 * 1.1 + 20 * -0.5 + 0.5$

$= 11 + (-10) + 0.5 = 1.5$

Applying Sigmoid function

$$H_3 = \frac{1}{1+e^{(-1.5)}} \Rightarrow \frac{1}{1+0.22316}$$

$$H_3 = \frac{1}{1.22316} \Rightarrow \boxed{0.81755}$$

Calculating $O_1$

$O_1 = outH_1 * w_7 + outH_2 * w_8 + outH_3 * w_9 + b_2$

$O_1 = 0.999 * 1.1 + 0.01000 * 0.5 + 0.817554 * 0.7 + 0.9$

$O_1 = 1.098 + 0.005 + 0.571 + 0.9$

$O_1 = 2.574$

Applying Sigmoid function.

$$O_1 = \frac{1}{1+(2.718)^{(-2.574)}} = \frac{1}{1.076} = 0.929$$

$\boxed{O_1 = 0.929}$

Calculating $O_2$

$O_2 = outH_1 * w_{10} + outH_2 * w_{11} + outH_3 * w_{12}$

$O_2 = 0.999 * (-0.4) + 0.0100 * 0.3 + 0.817 * 0.2$

$O_2 = 0.3996 + 0.003 + 0.163 + 0.9$

$O_2 = 0.666$

Applying Sigmoid

$$O_2 = \frac{1}{1+e^{-0.666}} = \frac{1}{1+0.595} = \frac{1}{1595}$$

$\boxed{O_2 = 0.626}$

Calculating total Error

formula $= \sum \frac{1}{2}(\text{target} - \text{output})^2$

expanding formula

$= \frac{1}{2}(T_1 - \text{out}_{o1})^2 + \frac{1}{2}(T_2 - \text{out}_{o2})^2$

Putting values

$= \frac{1}{2}(1 - 0.929)^2 + \frac{1}{2}(0 - 0.626)^2$

$= 0.00252 + 0.19593$

$= 0.198458$

$E_{total} = 0.198458$

Back propagation

calculating error at $w7 = \frac{dE_{total}}{dw7}$

using chain Rule

$$\frac{dE_{total}}{dw7} = \frac{dE_{total}}{d\text{out}_{o1}} * \frac{d\text{out}_1}{do_1} * \frac{do_1}{dw7}$$

$$\frac{dE_{total}}{d\text{out}_{o1}} = 2 * \frac{1}{2}(T_1 - \text{out}_{o1})^{2-1} * -1 + 0$$

$= (T_1 - \text{out}_{o1}) * -1 + 0$

$= -(T_1 - \text{out}_{o1})$

$= -(1 - 0.929)$

$$\frac{dE_{total}}{d\text{out}_{o1}} = \boxed{= 0.071}$$

$$\frac{d\,out_{o1}}{d\,o_1} = out_{o1}(1 - out_{o1})$$

$$= 0.929(1 - 0.929)$$

$$= \boxed{0.065959}$$

$$\frac{d\,o_1}{dw_7} = 1 * out_{H1} * (w_5)^{1-1}$$

$$= out_{H1} * 0 * 0$$

$$= out_{H1} \Rightarrow 0.999$$

$$\frac{d\,E_{total}}{dw_7} = -0.071 * 0.065959 * 0.999$$

$$= -0.00467 \quad \text{change in } w_7$$

updating $w_7$ values ($\eta = 0.2$)

$$w_7 = w_7 - \eta * \frac{d\,E_{total}}{dw_7}$$

$$= 1.1 - 0.2 * (-0.00467)$$

$$= \boxed{1.100934}$$

$$w_8 = \frac{d\,E_{total}}{dw_8}$$

$$\frac{d\,E_{total}}{dw_8} = \frac{d\,E_{total}}{out_{o1}} \times \frac{d\,out_{o1}}{d\,o_1} \times \frac{d\,o_1}{dw_8}$$

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$\frac{d E_{total}}{d out_1} = -(T_1 - out_{o1})$

$= -(1 - 0.729)$

$= -0.271$

$\frac{d out_{o1}}{d o_1} = out_{o1}(1 - out_{o1})$

$= 1 - 0.729(1 - 0.729)$

$= 0.0659$

$\frac{d o_1}{d w_8} = out_{H2} \Rightarrow 0.01000$

$\frac{d E_{total}}{d w_8} = -0.271 * 0.065959 * 0.01000$

$= -0.000046883089$

updating $w_8$

$w_8 = w_8 - \eta * \frac{d E_{total}}{d w_8}$

$w_8 = 0.5 - 0.2 * (-0.000046883089)$

$w_8 = 0.50009366$

$\frac{d E_{total}}{d w_4} = \frac{d E_{total}}{d out_1} * \frac{d out_1}{d o_1} * \frac{d o_1}{d w_4}$

$= -0.271 * 0.065959 * 0.817554$

$= 0.038286$

updating $w_4$

$w_4 = w_4 - \eta * \frac{d E_{total}}{d w_4}$

$= 0.7 - 0.2 \times (-0.038286$

$w_9 = \boxed{0.70765}$

Calculating $w_{10}$

$$\frac{d E_{total}}{d w_{10}} = \frac{d E_{total}}{d out_{o_2}} \times \frac{d out_{o_2}}{d o_2} \times \frac{d o_2}{d w_{10}}$$

$$\frac{d E_{total}}{d out_{o_2}} = -(T_2 - out_{o_2})$$

$$= -(0 - 0.626$$

$$= 0.626$$

$$\frac{d out_{o_2}}{d o_2} = out_{o_2}(1 - out_{o_2})$$

$$= 0.626(1 - 0.626)$$

$$= \boxed{0.2341}$$

$$\frac{d o_2}{d w_{10}} = out_{H_4} = \boxed{0.99944}$$

$$\frac{d E_{total}}{d w_{10}} = 0.626 * 0.2341 * 0.99944$$

$= 0.14646534$ change in $w_{10}$

updating $w_{10}$

$$w_{10} = w_{10} - \eta * \frac{d E_{total}}{d w_{10}}$$

$= -0.4 - 0.2 * (0.146464534)$

$= -0.429292907$

calculating $w_{11}$

$$\frac{dE_{total}}{dw_{11}} = \frac{dE_{total}}{dout_{o2}} * \frac{dout_{o2}}{do_2} * \frac{do_2}{dw_{11}}$$

$= 0.626 * 0.2341 * 0.01000$

$= 0.001465986$ change in $w_{11}$

updating $w_{11}$

$$w_{11} = w_{11} - \eta * \frac{dE_{total}}{dw_{11}}$$

$= 0.2 - 0.2 * (0.00146)$

$w_{11} = \boxed{0.299706900}$

$$\frac{dE_{total}}{dw_{12}} = \frac{dE_{total}}{dout_2} * \frac{dout_{o2}}{do_2} * \frac{do_2}{dw_{12}}$$

Putting value we find before

$= 0.626 * 0.2341 * 0.817554$

$= 0.1198,09759$

updating $w_{12}$

$w_{12} = 0.2 - 0.2 * (0.11980975)$

$= \boxed{0.176038043}$

Calculating weights on hidden layer

~~Error~~ $\delta o_1 = (T_1 - out o_1)\, out o_1 (1 - out o_1)$

~~Error~~ $o_2 = \delta o_2 = (T_2 - out o_2)\, out o_2 (1 - out o_2)$

~~Error~~ $h_1 = \delta h_1 = out h_1 (1 - out h_1)(\delta o_1 * w_7 + \delta o_2 * w_8)$

$\delta o_1 = (1 - 0.929) * 0.929(1 - 0.929)$

$= 0.071 * 0.065959$

$= 0.0046839$

$\delta o_2 = (0 - 0.626) * 0.626(1 - 0.626)$

$= -0.626 * 0.626(0.374)$

$= -0.626 * 0.234124$

$= -0.1465$

$\delta h_1 = 0.999(1 - 0.999) * (0.0046839 * 1.100$
$9349) + (-0.1465) * (0.500009)$

$= 0.999(0.001) * (0.00515 + (-0.0733)$

$0.000999 * -0.06815$

$\delta h_1 = -0.00006808$

$w_1 = w_1 - \eta \delta h_1 * I_1$

$= 0.2 - 0.2(0.0006808) * 10$

$= 0.2986384$

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$\delta h_2 = outh_2(1-outh_2)(\delta o_1 \times w_4 + \delta o_2 \times w_5)$

$= 0.01000(1-0.1000)(0.0046839 * 0.70765 + -0.1465 * -0.4292929207)$

$= 0.01000(1-0.1000) * (0.0002.8452)$

$= -0.005152$

$w_2 = w_2 - \eta \delta h_2 * I_1$

$= 0.2 - 02(0.005152) * 10$

$= 0.189$

$\delta h_3 = outh_3(1-outh_3)(\delta o_1 * w_{11} + \delta o_2 * w_{12})$

$= 0.81755(1-0.81755)(0.0046839 * 0.2997069 0 + (0.1465) * 0.176$

$= 0.003637$

$w_3 = w_3 - \eta \delta h_3 I_1$

$= -0.1 - 0.2(0.003637) * 10$

$= -0.107274$

$$w_4 = w_4 - \eta_{sh_1} * I_2$$

$$= -0.2 - 0.2(-0.00006808 * 20)$$

$$= -0.19972768$$

$$w_5 = w_5 - \eta_{sh_2} * I_2$$

$$= 1.1 - 0.2(-0.005152) * 20$$

$$= 1.079392$$

$$w_6 = w_6 - \eta_{sh_3} * I_2$$

$$= -0.5 - 0.2(-0.003637) * 20$$

$$\boxed{= -0.514548}$$