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Quiz-5

Question 1:

EPOCH 1- for input A=0, B=0, C=0, Target =0

$D_{net} = A \cdot W_{ad} + B \cdot W_{bd} + C \cdot W_{bd}$

$= (0 \times 1.0) + (0 \times 1.4) + (0 \times 2.2) = 0.0$

$D_{out} = \text{sigmoid}(0.0) = 0.5$

$E_{net} = (0 \times -1.0) + (0 \times 1.5) + (0 \times 2.7) = 0.0$

$E_{out} = \text{sigmoid}(0.0) = 0.5$

$F_{net} = (0 \times 1.2) + (0 \times 1.6) + (0 \times 2.3) = 0.0$

$F_{out} = \text{sigmoid}(0.0) = 0.5$

$G_{net} = (0 \times 1.3) + (0 \times 2.1) + (0 \times 2.1) = 0.0$

$G_{out} = \text{sigmoid}(0.0) = 0.5$

Output Layer: Net Input & Output

$O_{net} = (D_{out} \times W_{do}) + (E_{out} \times W_{eo}) + (F_{out} \times W_{FO}) + (G_{out} \times W_{go})$

$= (0.5 \times 3.1) + (0.5 \times 4.1) + (0.5 \times 2.1) + (0.5 \times 2.9)$

$= 1.55 + 2.05 + 1.05 + 1.45 = 6.1$

$O_{out} = \text{sigmoid}(6.1) \approx 0.9978$

$$\text{Sigmoid}(x) = \frac{1}{1+e^{-x}}$$

Error & Weight Update

target output = 0

Error = Target - O_{out}

$= 0 - 0.9978 = -0.9978$

to update weights we need to

1. compute derivative of the output activation

Target = 0

= 0.0

×2·7) = 0.0

·3) = 0.0

·1) = 0.0

ut × W_{FO}) +
(G_{out} × W_{GO})
(0.5 × 2.9)

moid (x) = $\frac{1}{1+e^{-x}}$

activation

$$\delta_o = (O_{target} - O_{out}) \cdot O_{out} \cdot (1 - O_{out})$$
$$= -0.9978 \times 0.9978 \times (1 - 0.9978)$$
$$\approx -0.0022$$

2. Then update weights from hidden to output

$W_{do-new} = W_{do} + \eta \times \delta_o \times D_{out}$

where η is learning rate, lets use 0.1

$W_{do} = 3.1 + 0.1 (-0.0022) \times 0.5$
$\approx 3.1 - 0.00011$
$= 3.09989$

$W_{eo} = 4.1 + 0.1 (-0.0022) \cdot 0.5 =$
$= 4.1 - 6.00011$
$= 4.09989$

$W_{FO} = 2.1 + 0.1 (-0.0022) \cdot 0.5$
$= 2.1 - 0.00011$
$= 2.09989$

$W_{GO} = 2.9 + 0.1 (-0.0022) \cdot 0.5$
$= 2.9 - 0.00011$
$= 2.89989$

EPOCH 1 = input A=0, B=0, C=1, Target = 1

$D_{net} = (0 \times 1.0) + (0 \times 0.14) + (1 \times 2.2) = 2.2$
$D_{out} = \sigma(2.2) \approx 0.9002$

$E_{net} = 0 (-1.00) + 0 (0 \times 1.5) + (1 \times 2.7) = 2.7$
$E_{out} = \sigma(2.7) \approx 0.9370$

$F_{net} = (0 \times 1.2) + (0 \times 1.6) + (1 \times 2.3) = 2.3$
$F_{out} = \sigma(2.3) \approx 0.9089$

$G_{net} = (0 \times 1.3) + (0 \times 2.1) + (1 \times 2.1) = 2.1$
$G_{out} = \sigma(2.1) \approx 0.8909$

Step 2 - Output layer
using updated weights from previous step

$O_{net} = (0.9002 \times 3.09989) + (0.9370 \times 4.09989)$
$+ (0.9089 \times 2.09989) + (0.8909 \times 2.89989)$

$= 2.789 + 3.841 + 1.908 + 2.583 = 11.121$

$O_{out} = \sigma(11.121) \approx 0.99999$

Step 3 - error & weights

Target = 1

$O_{out} \approx 0.99999$

Error $\approx 1 - 0.99999 = 0.00001$

Output delta :

$\delta_o = (1 - 0.99999) \times (0.99999)(1 - 0.99999)$

$\approx 0.00001 \times 0.99999 \times 0.00001$

$\approx 1e-10$

this is a very small error, so, weights updates will be almost negligible

updated weights

using the same formula

$W_{new} = W_{old} + 0.1 \cdot \delta_o \cdot$ hidden output

Eg:

$W_{do} = 3.09989 + 0.1 \cdot (1e-10) \cdot 0.9002$

$\approx 3.09989 + 9e-12$

≈ 3.09989

so, all weights stay nearly the same due to extremely low error.

...rious step

...70 X 4.09989)

...9 X 2.89989)

...3 = 11.121

...-0.99999)

...001

...updates will be

...n output

...002

...ue to extremely

EPOCH = input A=0, B=1, C=0, Target = 1

Step 1 - Hidden layer - net input & output

$D_{net} = (0\times0.1) + (1\times1.4) + (0\times0.22) = 1.4$

$D_{out} = \sigma(1.4) \approx 0.8022$

$E_{net} = 0\times(-1.0) + (1\times1.5) + (0\times9.7) = 1.5$

$E_{out} = \sigma(1.5) \approx 0.8176$

$F_{net} = (0\times1.2) + (1\times1.6) + (0\times2.3) = 1.6$

$F_{out} = \sigma(1.6) \approx 0.8320$

$G_{net} = (0\times1.3) + (1\times2.1) + (0\times2.1) = 2.1$

$G_{out} = \sigma(2.1) \approx 0.8909$

Step 2 : output layer - net input and output

$O_{net} = (0.8022\times3.09989) + (0.8176\times4.09989) + (0.8320\times2.09989) + (0.8909\times2.89989)$

$O_{net} = 2.485 + 3.351 + 1.747 + 2.583 = 10.166$

$O_{out} = \sigma(10.166) \approx 0.99996$

Step 3 = Error & update

target = 1

$O_{out} = 0.99996$

$Error = 1 - 0.99996 = 0.00004$

$\delta_o = 0.00004 \times 0.99996(1 - 0.99996) = 1.6e-9$

eg: $W_{do} = 3.09989 + 0.1(1.6e-9)\cdot0.8022 \approx 3.09989 + 1.28e-10 \approx 3.09989$

overall weight change is negligible due to tiny error.

Epoch 5 input A=0, B=1, C=1, Target =0

step 1 - Hidden layer - net input & output

Dnet = (0×1.0) + (1×1.4) + (1×1.22) = 3.66

Dout = σ(3.6) = 0.9734

Enet = 0.(-1.0) + (1×1.5) + (1×2.7) = 4.2

Eout = σ(4.2) = 0.9853

Fnet = (0×1.2) + (1×1.6) + (1×1.23) = 3.9

Fout = 0.9801

Gnet = (0×1.3) + (1×2.1) + (1×2.5) = 4.2

Gout = σ(4.2) = 0.9853

step 2 - output layer - net input & output

Onet = (0.9734 × 3.09989) + (0.9853 × 4.09989) + (0.9801 × 2.09989) + (0.9853 × 2.89989)

Onet = 3.015 + 4.038 + 2.059 = 11.967

Oout = σ(11.967) ≈ 0.9999937

step 3: error & update

Target = 0

Oout = 0.9999937

Error = 0 - 0.9999937 = -0.9999937

$\delta_o = -0.9999937 \times 0.9999937 \times (1 - 0.9999937)$

$\approx -6.3e-6$

Weight updates

$W_{new} = W_{old} + \eta \cdot \delta_o \cdot$ hidden output

$W_{do} = 3.09989 + 0.1 \times (-6.3e-6) \cdot 0.9734$

$= 3.09929$

$W_{eo} = 4.09989 - 0.1 \times 6.3e-6 \times 0.9853$

$= 4.09927$

$W_{fo} = 2.09989 - 0.1 \times 6.3e-6 \times 0.9801$

$= 2.09927$

$W_{go} = 2.89989 - 0.1 \times 6.3e-6 \times 0.9853$

$= 2.89927$

Summar

input
000
001
010
011

ange =0
utput
= 3.6

= 4.2

3.9

= ~~3.9~~ 4.2
0.9853
utput
0.9853 × 4-0.9989)
0.9853 × 2.89989)
11.967
0.9999937

9999937
7×(1 − 0.9999937)

idden output

0.9734

0.9853

.9801

× 0.9853

Summary Table

input	Target	Oout	Error	ΔO
000	0	0.9978	-0.9978	-0.0022
001	1	0.99999	0.00001	~1e-10
010	1	0.99996	0.00004	~1.6e-9
011	0	0.99999	-0.99999	~6.3e-6