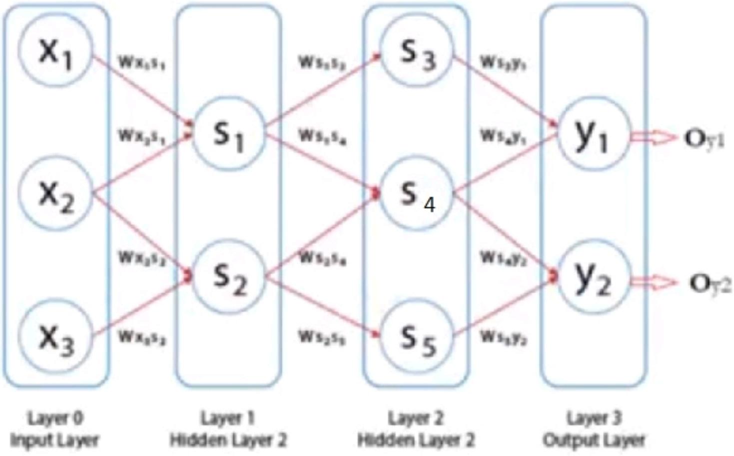
Task

For the given Network, perform feed forward and back propagation and find all the appropriate values.

Term	Value	Term	Value	Term	Value
Input x1	0.7	Input x2	0.15	Input x3	0.61
W_{x1s1}	0.25	W_{s2s5}	0.85	θ_{s3}	0.5
W_{x2s1}	0.33	W_{s2y1}	0.11	θ_{s4}	0.19
W_{x2s2}	0.12	W_{s4y1}	0.51	θ_{s5}	0.33
W_{x3s2}	-0.7	W_{s4y2}	-0.35	θ_{y1}	0.8
W_{s1s3}	-0.36	W_{s5y2}	-0.42	θ_{y2}	0.09
W_{s1s4}	0.7	θ_{s1}	0.7	T_{y1}	1
W_{s2s4}	0.22	θ_{s2}	0.2	T_{y2}	0



Date

NAME: Shaikh Haris Ali

SEAT NO: B18158049

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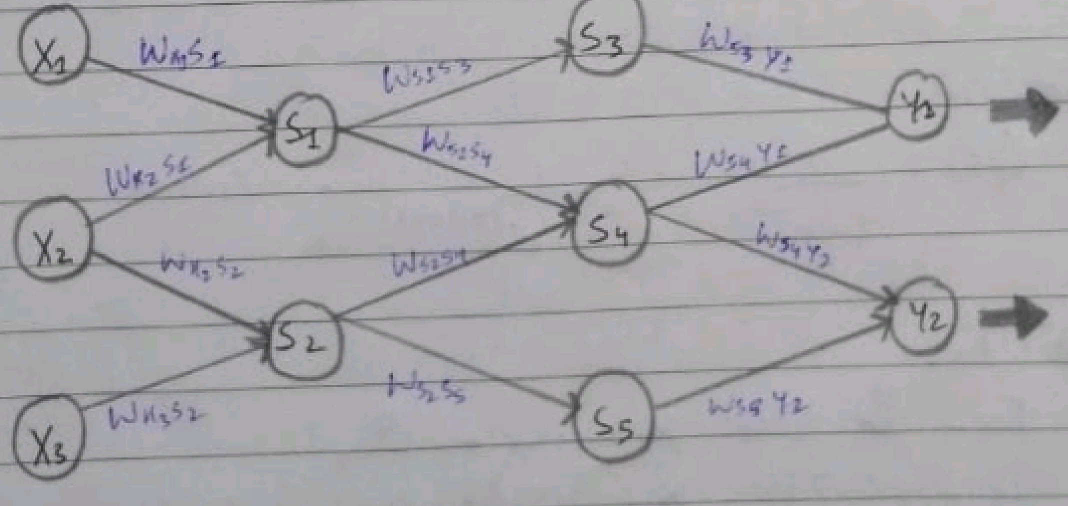

Output Layer Error:

$$Err\,y_1 = O_{y_1}(1 - O_{y_1})(T_{y_1} - O_{y_1})$$
$$= 0.771(1 - 0.771)(1 - 0.771)$$
$$= 0.04$$

$$Err\,y_2 = O_{y_2}(1 - O_{y_2})(T_{y_2} - O_{y_2})$$
$$= 0.394(1 - 0.394)(0 - 0.394)$$
$$= -0.094$$

Hidden Layer Error:

$$Err\,S_3 = O_{S_3}(1 - O_{S_3})[Err\,y_1 \times W_{S_3Y_1}]$$
$$\cancel{= O_{S_3}(1}$$
$$= 0.56(1 - 0.56)[0.04 \times 0.11]$$
$$= 0.001$$

$$Err\,S_4 = O_{S_4}(1 - O_{S_4})\sum_{k=1}^{2}[Err_k\,W_{jk}]$$
$$= O_{S_4}(1 - O_{S_4})(Err\,y_1\,W_{S_4Y_1} + Err\,y_2\,W_{S_4Y_2})$$
$$= 0.688(1 - 0.688)(0.04 \times 0.51 + (-0.094) \times -0.35)$$
$$= 0.01$$

$$Err\,S_5 = O_{S_5}(1 - O_{S_5})[Err\,y_2\,W_{S_5Y_2}]$$
$$= 0.671(1 - 0.671)(-0.094 \times -0.42)$$
$$= 0.0087$$

$$Err\,S_1 = O_{S_1}(1 - O_{S_1})[Err\,S_3 \times W_{S_1S_3} + Err\,S_4 \times W_{S_1S_4}]$$
$$= 0.716(1 - 0.716)(0.001 \times -0.36 + 0.01 \times 0.7)$$
$$= 0.0013$$

For O_{S_3}:

$$O_{S_3} = \frac{1}{1+e^{-I_{S_3}}} = \frac{1}{1+e^{-(0.242)}} = 0.56$$

For I_{S_4}:

$$I_{S_4} = O_{S_1} \times W_{S_1S_4} + O_{S_2} \times W_{S_2S_4} + \theta_{S_4}$$
$$= 0.716 \times 0.7 + 0.448 \times 0.22 + 0.19 = 0.78976$$

For O_{S_4}:

$$O_{S_4} = \frac{1}{1+e^{-I_{S_4}}} = \frac{1}{1+e^{-(0.78976)}} = 0.688$$

For I_{S_5}:

$$I_{S_5} = O_{S_2} \times W_{S_2S_5} + O_{S_5} = (0.2 \times 0.85) + 0.33$$
$$= 0.711$$

For O_{S_5}:

$$O_{S_5} = \frac{1}{1+e^{-I_{S_5}}} = \frac{1}{1+e^{-(0.711)}} = 0.671$$

For I_{Y_1}

$$I_{Y_1} = O_{S_3} \times W_{S_3Y_1} + O_{S_4} \times W_{S_4Y_1} + \theta_{Y_1}$$
$$= 0.56 \times 0.11 + 0.688 \times 0.51 + 0.8 = 1.212$$

For O_{Y_1}:

$$O_{Y_1} = \frac{1}{1+e^{-I_{Y_1}}} = \frac{1}{1+e^{-(1.212)}} = 0.394$$

For I_{Y_2}: $O_{S_4} \times W_{S_4Y_2} + O_{S_5} \times W_{S_5Y_2} + \theta_{Y_2}$

$$I_{Y_2} = 0.688 \times (-0.35) + 0.671 \times (-0.42) + 0.09 = -0.43262$$

For O_{Y_2}: $O_{Y_2} = \frac{1}{1+e^{-I_{Y_2}}} = 0.394$

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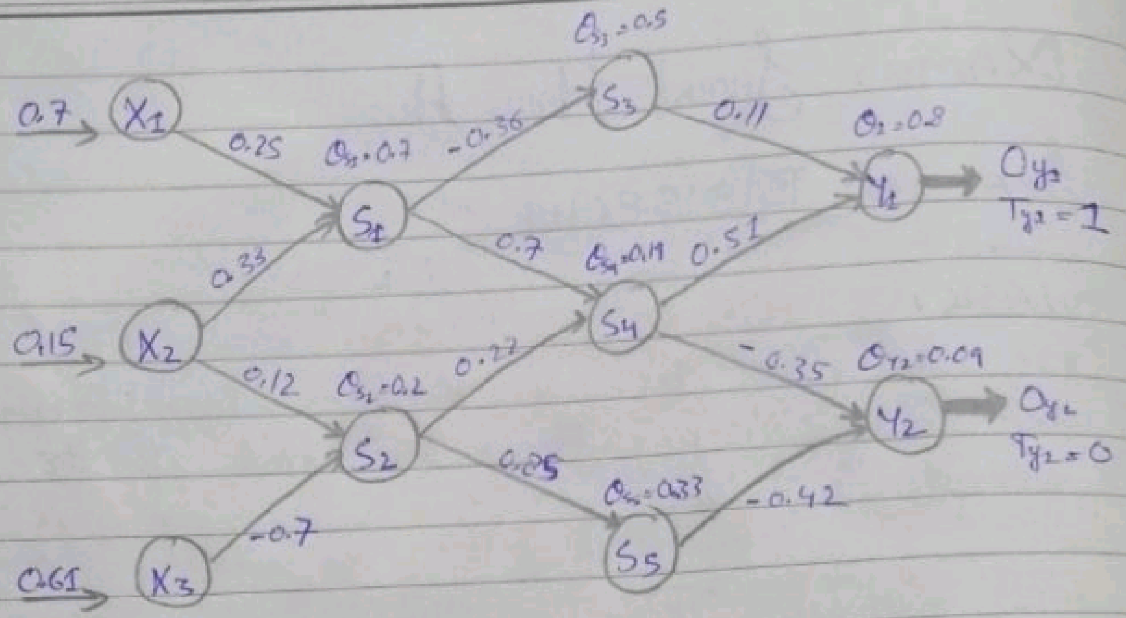


For I_{S1} :-

$$I_{S1} = I_{X1} \times W_{X1S1} + I_{X2} \times W_{X2S1} + \theta_{S1}$$
$$= (0.7 \times 0.25) + (0.15 \times 0.33) + 0.7 = 0.9245$$

For O_{S1} :

$$O_{S1} = \frac{1}{1+e^{-I_{S1}}} = \frac{1}{1+e^{-(0.9245)}} = 0.716$$

For I_{S2} :

$$I_{S2} = I_{X2} \times W_{X2S2} + I_{X3} \times W_{X3S2} + \theta_{S2}$$
$$= 0.15 \times 0.12 + 0.61 \times (-0.7) + 0.2 = -0.209$$

For O_{S2} :

$$O_{S2} = \frac{1}{1+e^{-I_{S2}}} = \frac{1}{1+e^{-(0.209)}} = 0.448$$

For I_3 :

$$I_3 = O_{S1} \times W_{S1S3} + \theta_{S3}$$
$$I_3 = 0.716 \times (-0.36) + 0.5 = 0.242$$

Date: ______

FEED FORWARD

$$I_{S1} = I_{X1} \times W_{X1S1} + I_{X2} \times W_{X2S1} + \theta_{S1}$$
$$= 0.7 \times 0.25 + 0.15 \times 0.33 + 0.7$$
$$= 0.9245$$

$$O_{S1} = 1/1+e^{-I_{S1}} = 0.716$$

$$I_{S2} = I_{X2} \times W_{X2S2} + I_{X3} \times W_{X3S2} + \theta_{S2}$$
$$= 0.15 \times 0.12 + 0.61 \times -0.7 + 0.2$$
$$= -0.209$$

$$O_{S2} = 0.448$$

$$I_{S3} = O_{S1} \times W_{S1S3} + \theta_{S3}$$
$$= 0.716 \times -0.36 + 0.5$$
$$= 0.242$$

$$O_{S3} = 1/1+e^{-I_{S3}} = 0.56$$

$$I_{S4} = O_{S1} \times W_{S1S4} + O_{S2} \times W_{S2S4} + \theta_{S4}$$
$$= 0.716 \times 0.7 + 0.448 \times 0.22 + 0.19$$
$$= 0.78976$$

$$O_{S4} = 1/1+e^{-I_{S4}} = 0.688$$

$$I_{S5} = O_{S2} \times W_{S2S5} + \theta_{S5}$$
$$= 0.448 \times 0.85 + 0.33$$
$$= 0.711$$

$$O_{S5} = 1/1+e^{-I_{S5}} = 0.671$$

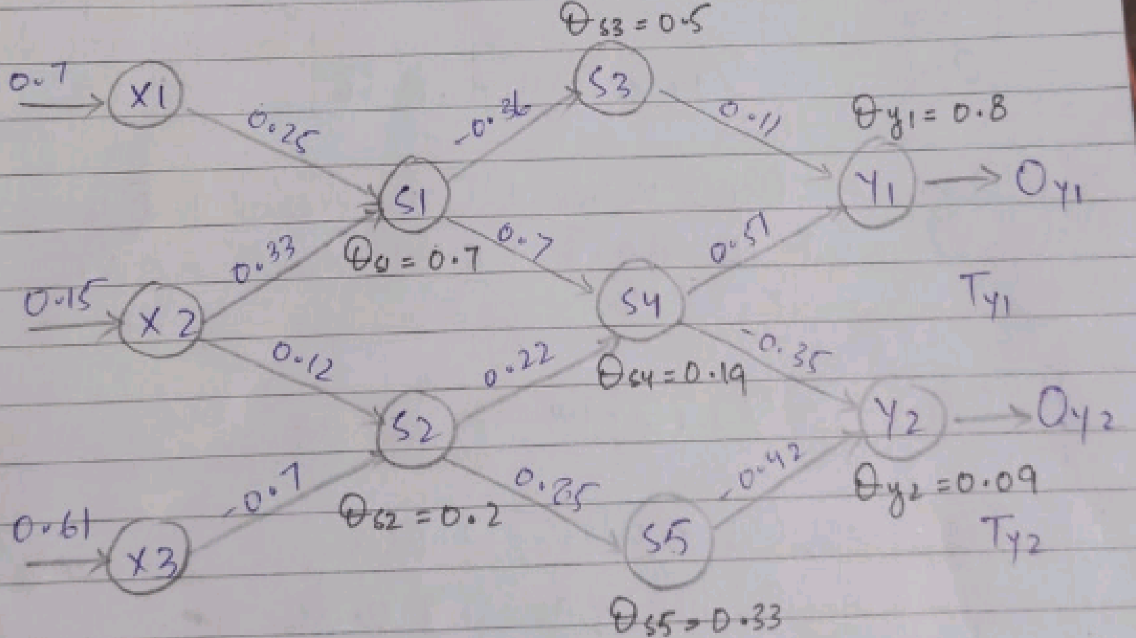
ASSIGNMENT # 04

Date: 22-Nov-2021

SUBMITTED BY: BISMA KHAN (B18158008)

QUESTION 1: For the given network, perform feed forward and back propogation and find all the appropriate values.

Term	Value	Term	Value	Term	Value
Input x1	0.7	Input x2	0.15	Input x3	0.61
w_{x1s1}	0.25	w_{s2s5}	0.85	θ_{s3}	0.5
W_{x2s1}	0.33	W_{s3y1}	0.11	θ_{s4}	0.19
W_{x2s2}	0.12	W_{s4y1}	0.51	θ_{s5}	0.33
W_{x3s2}	-0.7	W_{s4y2}	-0.35	θ_{y1}	0.8
W_{s1s3}	-0.36	W_{s5y2}	-0.42	θ_{y2}	0.09
W_{s1s4}	0.7	θ_{s1}	0.7	T_{y1}	1
W_{s2s4}	0.22	θ_{s2}	0.2	T_{y2}	0



Layer 0 — Input layer

Layer 1 — Hidden Layer 2

Layer 2 — Hidden Layer 2

Layer 3 — Output layer

Date:

$Err_{s5} = O_{s5}(1-O_{s5})[Err_{y2} W_{s5y2}]$
$= 0.671(1-0.671)(-0.094 \times -0.42)$
$= 0.0087$

$Err_{s1} = O_{s1}(1-O_{s1})[Err_{s3} W_{s1s3} + Err_{s4} W_{s1s4}]$
$= 0.716(1-0.716)(0.001 \times -0.36 + 0.01 \times 0.7)$
$= 0.00135$

$Err_{s2} = O_{s2}(1-O_{s2})[Err_{s4} W_{s2s4} + Err_{s5} W_{s2s5}]$
$= 0.448(1-0.448)(0.01 \times 0.22 + 0.0087 \times 0.85)$
$= 0.00237$

Here, the errors at output layer and hidden layer is very minimum, so we can assume that network follows vanishing gradient problem and weights and biasis will not change, we can calculate update biasis and weights to prove this problem.

UPDATE BIASIS

Formula : $\theta_j = \theta_j + \Delta\theta_j$
$= \theta_j + l\, Err_j$

We assume that learning rate = 0.1, because error is very minimum / small.
So,
$l = 0.1$

$\theta_{s1} = \theta_{s1} + l\, Err_{s1}$
$= 0.7 + 0.1(0.00135)$
$= 0.7$

$$\theta_{s2} = \theta_{s2} + l\, Err_{s2}$$
$$= 0.2 + 0.1(0.00237)$$
$$= 0.2$$

$$\theta_{s3} = \theta_{s3} + l\, Err_{s3}$$
$$= 0.5 + 0.1(0.001)$$
$$= 0.5$$

$$\theta_{s4} = \theta_{s4} + l\, Err_{s4}$$
$$= 0.19 + 0.1(0.01)$$
$$= 0.19$$

$$\theta_{s5} = \theta_{s5} + l\, Err_{s5}$$
$$= 0.33 + 0.1(0.0087)$$
$$= 0.33$$

$$\theta_{y1} = \theta_{y1} + l\, Err_{y1}$$
$$= 0.8 + 0.1(0.04)$$
$$= 0.8$$

$$\theta_{y2} = \theta_{y2} + l\, Err_{y2}$$
$$= 0.09 + 0.1(-0.094)$$
$$= 0.0806$$

UPDATE WEIGHTS

Formula : $w_{ij} = w_{ij} + \Delta w_{ij}$
$$= w_{ij} + l\, Err_j\, O_i$$

$$W_{x1s1} = W_{x1s1} + l\, Err_{s1}\, O_{x1}$$
$$= 0.25 + 0.1(0.00135)(0.7)$$
$$= 0.25$$

Date:

$I_{y_1} = O_{s3} \times W_{s3y1} + O_{s4} \times W_{s4y1} + \theta_{y1}$
$= 0.56 \times 0.11 + 0.688 \times 0.57 + 0.8$
$= 1.212$

$O_{y_1} = 1/1+e^{-I_{y1}} = 0.771$

$I_{y_2} = O_{s4} \times W_{s4y2} + O_{s5} \times W_{s5y2} + \theta_{y2}$
$= 0.688 \times -0.35 + 0.671 \times -0.42 + 0.09$
$= -0.43262$

$O_{y_2} = 1/1+e^{-I_{y2}} = 0.394$

BACK PROPOGATION

OUTPUT LAYER ERROR

$Err_{y_1} = O_{y_1}(1-O_{y_1})(T_{y1} - O_{y_1})$
$= 0.771(1-0.771)(1-0.771)$
$= 0.04$

$Err_{y_2} = O_{y_2}(1-O_{y_2})(T_{y2} - O_{y_2})$
$= 0.394(1-0.394)(0-0.394)$
$= -0.094$

HIDDEN LAYER ERROR

$Err_{s3} = O_{s3}(1-O_{s3})[Err_{y1} W_{s3y1}]$
$= 0.56(1-0.56)(0.04 \times 0.11)$
$= 0.001$

$= O_{s4}(1-O_{s4})[Err_{y1} W_{s4y1} + Err_{y2} W_{s4y2}]$
$Err_{s4} = 0.688(1-0.688)(0.04 \times 0.51 + (-0.094 \times -0.35))$
$= 0.01$

Date:

$$W_{x2s1} = W_{x2s1} + l \, Err_{s1} \, O_{x2}$$
$$= 0.33 + 0.1(0.00135)(0.15)$$
$$= 0.33$$

$$W_{x2s2} = W_{x2s2} + l \, Err_{s2} \, O_{x2}$$
$$= 0.12 + 0.1(0.00237)(0.15)$$
$$= 0.12$$

$$W_{x3s2} = W_{x3s2} + l \, Err_{s2} \, O_{x3}$$
$$= -0.7 + 0.1(0.00237)(0.61)$$
$$= -0.7$$

$$W_{s1s3} = W_{s1s3} + l \, Err_{s3} \, O_{s1}$$
$$= -0.36 + 0.1(0.001)(0.716)$$
$$= -0.36$$

$$W_{s1s4} = W_{s1s4} + l \, Err_{s4} \, O_{s1}$$
$$= 0.7 + 0.1(0.01)(0.716)$$
$$= 0.7$$

$$W_{s2s4} = W_{s2s4} + l \, Err_{s4} \, O_{s2}$$
$$= 0.22 + 0.1(0.01)(0.448)$$
$$= 0.22$$

$$W_{s2s5} = W_{s2s5} + l \, Err_{s5} \, O_{s2}$$
$$= 0.85 + 0.1(0.0087)(0.448)$$
$$= 0.85$$

$$W_{s3y1} = W_{s3y1} + l \, Err_{y1} \, O_{s3}$$
$$= 0.11 + 0.1(0.04)(0.58)$$
$$= 0.11$$

Date:

$$W_{s4y1} = W_{s4y1} + l \, Err_{y1} \, O_{s4}$$
$$= 0.51 + 0.1(0.04)(0.688)$$
$$= 0.51$$

$$W_{s4y2} = W_{s4y2} + l \, Err_{y2} \, O_{s4}$$
$$= -0.35 + 0.1(-0.094)(0.688)$$
$$= -0.356$$

$$W_{s5y2} = W_{s5y2} + l \, Err_{y2} \, O_{s5}$$
$$= -0.42 + 0.1(-0.094)(0.671)$$
$$= -0.42$$

Final Result

As the weights and biasis remain same and does not change and error is very small so we don't proceed further with successive iterations.

The final predictions (output) will be

$$O_{y1} = 0.771$$

$$O_{y2} = 0.394$$

$Err_{S_2} = O_{S_2}(1 - O_{S_2})(Err_{S_4} \times W_{S_2S_4} + Err_{S_4} \times W_{S_5S_4})$
$= 0.448\ (1 - 0.448)(0.01 \times 0.22 + 0.0087 \times 0.85)$
$= 0.00237$

UPDATING WEIGHT:

$l = 0.1$

$W_{S_3Y_1} = W_{S_3Y_1} + \Delta W_{S_3Y_1}$
$= 0.11 + l\ Err_{Y_1}\ O_{S_3}$
$= 0.11 + (0.1)(0.04)(0.56)$
$W_{S_3Y_1} = 0.11$

$W_{S_4Y_1} = W_{S_4Y_1} + \Delta W_{S_4Y_1}$
$= 0.51 + (0.1)(0.04)(0.688)$
$= 0.5$

$W_{S_4Y_2} = W_{S_4Y_2} + \Delta W_{S_4Y_2}$
$= -0.35 + (0.1)(-0.35)(0.688)$

$W_{S_5Y_2} = W_{S_5Y_2} + \Delta W_{S_5Y_2}$
$= -0.42 + (0.1)(-0.094)(0.671)$
$= -0.42$

$\because \Delta W_{S_1S_3} = l\ Err_{S_3}\ O_{S_1}$

$W_{S_1S_3} = W_{S_1S_3} + \Delta W_{S_1S_3}$
$= -0.36 + (0.1)(0.001)(0.716)$
$= -0.36$

$\because \Delta W_{S_1S_4} = l\ Err_{S_4}\ O_{S_1}$

$W_{S_1S_4} = W_{S_1S_4} + \Delta W_{S_1S_4}$
$= 0.7 + (0.1)(0.01)(0.716)$
$= 0.7$

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$$W_{s_2 s_4} = W_{s_2 s_4} + \Delta W_{s_2 s_4}$$
$$= W_{s_2 s_4} + l \; Err_{s_4} \; O_{s_2}$$
$$= 0.22 + (0.1)(0.01)(0.448)$$
$$W_{s_2 s_4} = 0.22$$

$$W_{s_2 s_4} = W_{s_2 s_5} + \Delta W_{s_2 s_5}$$
$$= 0.25 + (0.1)(0.0087)(0.448)$$
$$= 0.25$$

$$W_{x_1 s_1} = W_{x_1 s_1} + \Delta W_{x_1 s_1}$$
$$= 0.25 + l \; Err_{s_1} \; I_{x_1}$$
$$= 0.25 + (0.1)(0.0013)(0.7)$$
$$W_{x_1 s_1} = 0.25$$

$$W_{x_2 s_1} = W_{x_2 s_1} + \Delta W_{x_2 s_1}$$
$$= 0.33 + l \; Err_{s_1} \; I_{x_2}$$
$$= 0.33 + (0.1)(0.0013)(0.15)$$
$$= 0.33$$

$$W_{x_2 s_2} = W_{x s_2} + \Delta W_{x_2 s_2}$$
$$= 0.12 + l \; Err_{s_2} \; I_{x_2}$$
$$= 0.12 + (0.1)(0.00237)(0.15)$$
$$= 0.12$$

$$W_{x_3 s_2} = W_{x_3 s_2} + \Delta W_{x_3 s_2}$$
$$= -0.7 + l \; Err_{s_2} \; I_{x_3}$$
$$= -0.7 + (0.1)(0.00237)(0.61)$$
$$= -0.7$$

$$O_{y_2} = O_{y_2} + l \, Err_{y_2}$$

$$= 0.09 + (0.1)(-0.094)$$

$$O_{y_2} = 0.0806$$

Change In Biasis:

$\Delta \theta_j = l \, Err_j$

$\theta_{S1} = \theta_{S1} + \Delta \theta_{S1}$
$= \theta_{S1} + l \, Err_{S1}$
$= 0.7 + (0.1)(0.0013)$
$\theta_{S1} = 0.7$

$\theta_{S2} = \theta_{S2} + \Delta \theta_{S2}$
$= \theta_{S2} + l \, Err_{S2}$
$= 0.2 + (0.1)(0.00237)$
$= 0.2$

$\theta_{S3} = \theta_{S3} + l \, Err_{S3}$
$= 0.5 + (0.1)(0.001)$
$= 0.5$

$\theta_{S4} = \theta_{S4} + l \, Err_{S4}$
$= 0.19 + (0.1)(0.01)$
$= 0.19$

$\theta_{S5} = \theta_{S5} + l \, Err_{S5}$
$= 0.33 + (0.1)(0.0087)$
$\theta_{S5} = 0.33$

$\theta_{Y1} = \theta_{Y1} + l \, Err_{Y1}$
$= 0.8 + (0.1)(0.04)$
$= 0.8$