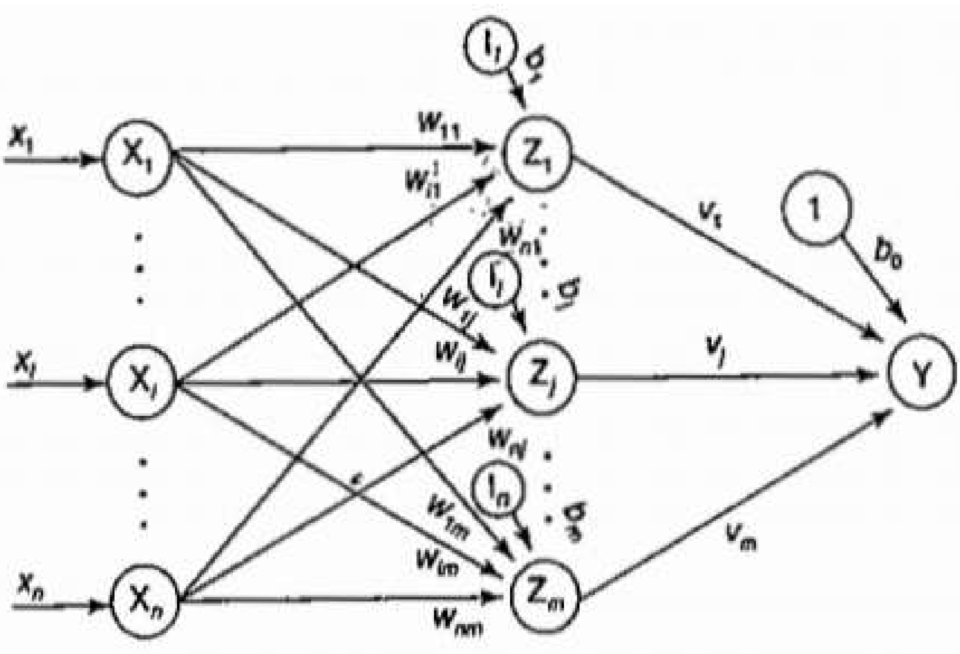
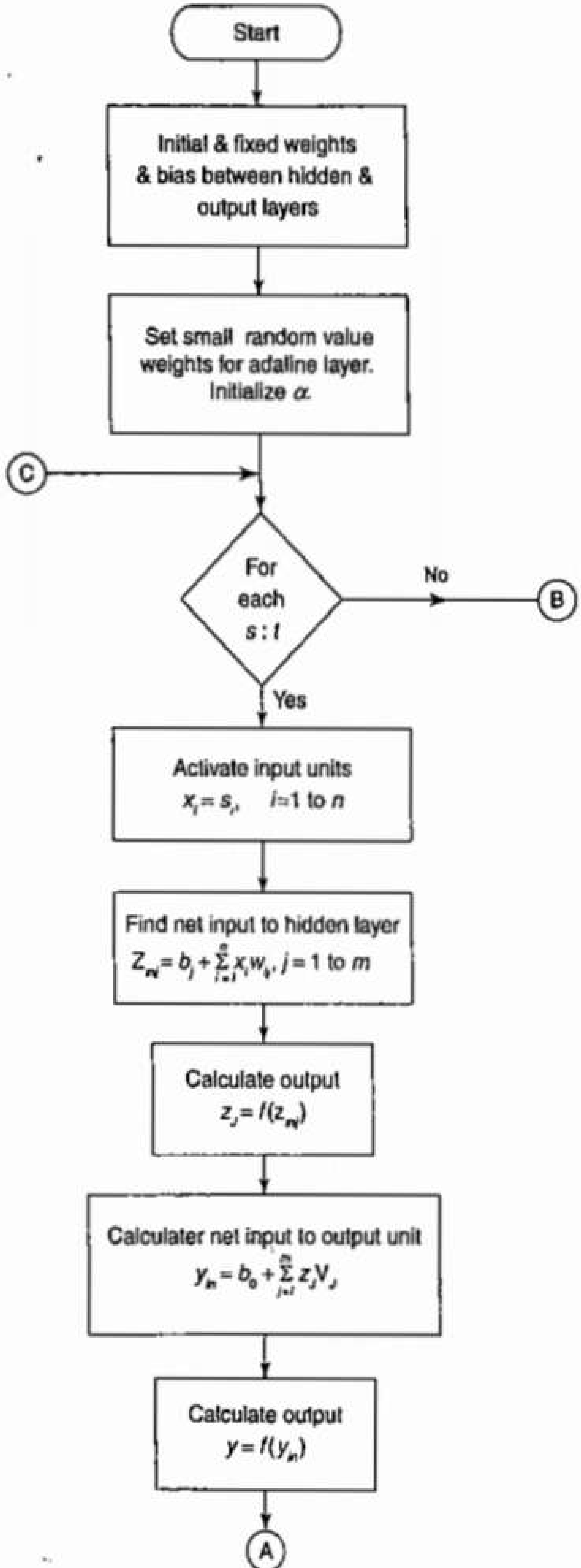


x_1
x_i
x_n
X_1
X_i
X_n
w_{11}
w_{i1}
w_{n1}
w_{1j}
w_{ij}
w_{nj}
w_{1m}
w_{im}
w_{nm}
Z_1
Z_j
Z_m
1_1
1_j
1_n
v_1
v_j
v_m
1
b_0
Y



Start
Initial & fixed weights & bias between hidden & output layers
Set small random value weights for adaline layer. Initialize α.
C
For each $s:t$
No
B
Yes
Activate input units $x_i = s_i$, $i=1$ to n
Find net input to hidden layer $Z_{inj} = b_j + \sum_{i=1}^{n} x_i w_{ij}$, $j = 1$ to m
Calculate output $z_j = f(z_{inj})$
Calculater net input to output unit $y_{in} = b_0 + \sum_{j=1}^{m} z_j V_j$
Calculate output $y = f(y_{in})$
A

Step 0: Initialize the weights. The weights entering the output unit are set as above. Set initial small random values for Adaline weights. Also set initial learning rate α.

Step 1: When stopping condition is false, perform Steps 2–3.

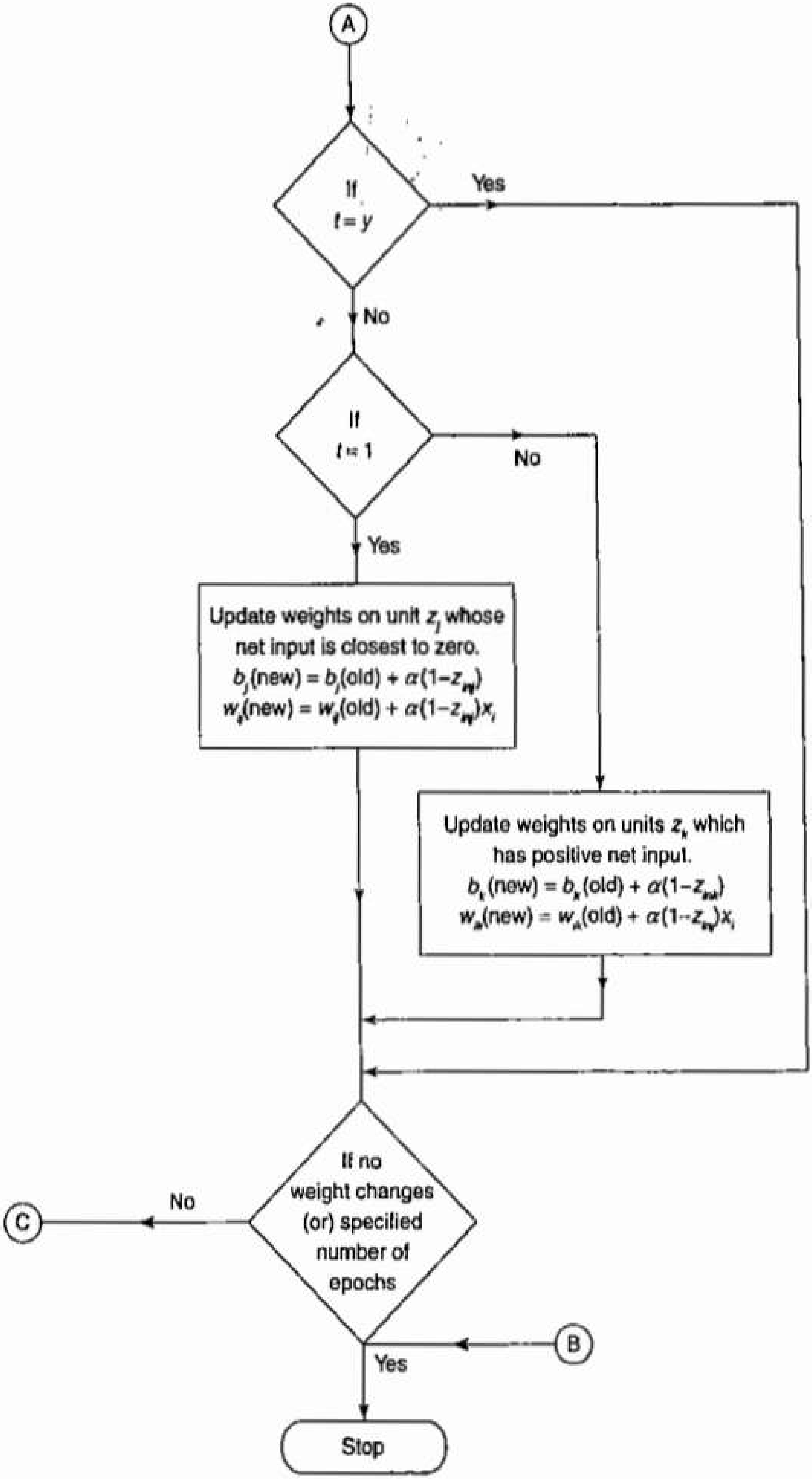
Step 2: For each bipolar training pair $s:t$, perform Steps 3–7.

Step 3: Activate input layer units. For $i = 1$ to n,

$$x_i = s_i$$

Step 4: Calculate net input to each hidden Adaline unit:

$$z_{inj} = b_j + \sum_{i=1}^{n} x_i w_{ij}, \quad j = 1 \text{ to } m$$



A
If $t = y$
Yes
No
If $t = 1$
No
Yes
Update weights on unit z_j whose net input is closest to zero.
$b_j(\text{new}) = b_j(\text{old}) + \alpha(1-z_{inj})$
$w_{ij}(\text{new}) = w_{ij}(\text{old}) + \alpha(1-z_{inj})x_i$
Update weights on units z_k which has positive net input.
$b_k(\text{new}) = b_k(\text{old}) + \alpha(1-z_{ink})$
$w_{ik}(\text{new}) = w_{ik}(\text{old}) + \alpha(1-z_{ink})x_i$
If no weight changes (or) specified number of epochs
No
C
B
Yes
Stop

Step 5: Calculate output of each hidden unit:

$$z_j = f(z_{inj})$$

Step 6: Find the output of the net:

$$y_{in} = b_0 + \sum_{j=1}^{m} z_j v_j$$
$$y = f(y_{in})$$

Step 7: Calculate the error and update the weights.

1. If $t = y$, no weight updation is required.
2. If $t \neq y$ and $t = +1$, update weights on z_j, where net input is closest to 0 (zero):

$$b_j(\text{new}) = b_j(\text{old}) + \alpha\,(1 - z_{inj})$$
$$w_{ij}(\text{new}) = w_{ij}(\text{old}) + \alpha\,(1 - z_{inj})x_i$$

3. If $t \neq y$ and $t = -1$, update weights on units z_k whose net input is positive:

$$w_{ik}(\text{new}) = w_{ik}(\text{old}) + \alpha\,(-1 - z_{ink})\,x_i$$
$$b_k(\text{new}) = b_k(\text{old}) + \alpha\,(-1 - z_{ink})$$

Step 8: Test for the stopping condition. (If there is no weight change or weight reaches a satisfacto or if a specified maximum number of iterations of weight updation have been perform stop, or else continue).

x_1	x_2	1	t
1	1	1	−1
1	−1	1	1
−1	1	1	1
−1	−1	1	−1

input sample, $x_1 = 1, x_2 = 1$, target $t = -1$, and learning rate α equal to 0.5:

- Calculate net input to the hidden units:

$$
\begin{aligned}
z_{in1} &= b_1 + x_1 w_{11} + x_2 w_{21} \\
&= 0.3 + 1 \times 0.05 + 1 \times 0.2 = 0.55 \\
z_{in2} &= b_2 + x_1 w_{12} + x_2 w_{22} \\
&= 0.15 + 1 \times 0.1 + 1 \times 0.2 = 0.45
\end{aligned}
$$

$$z_1 = f(z_{in1}) = f(0.55) = 1$$
$$z_2 = f(z_{in2}) = f(0.45) = 1$$

- After computing the output of the hidden units, then find the net input entering into the output unit:

$$\begin{aligned} y_{in} &= b_3 + z_1 v_1 + z_2 v_2 \\ &= 0.5 + 1 \times 0.5 + 1 \times 0.5 = 1.5 \end{aligned}$$

- Apply the activation function over the net input y_{in} to calculate the output y:

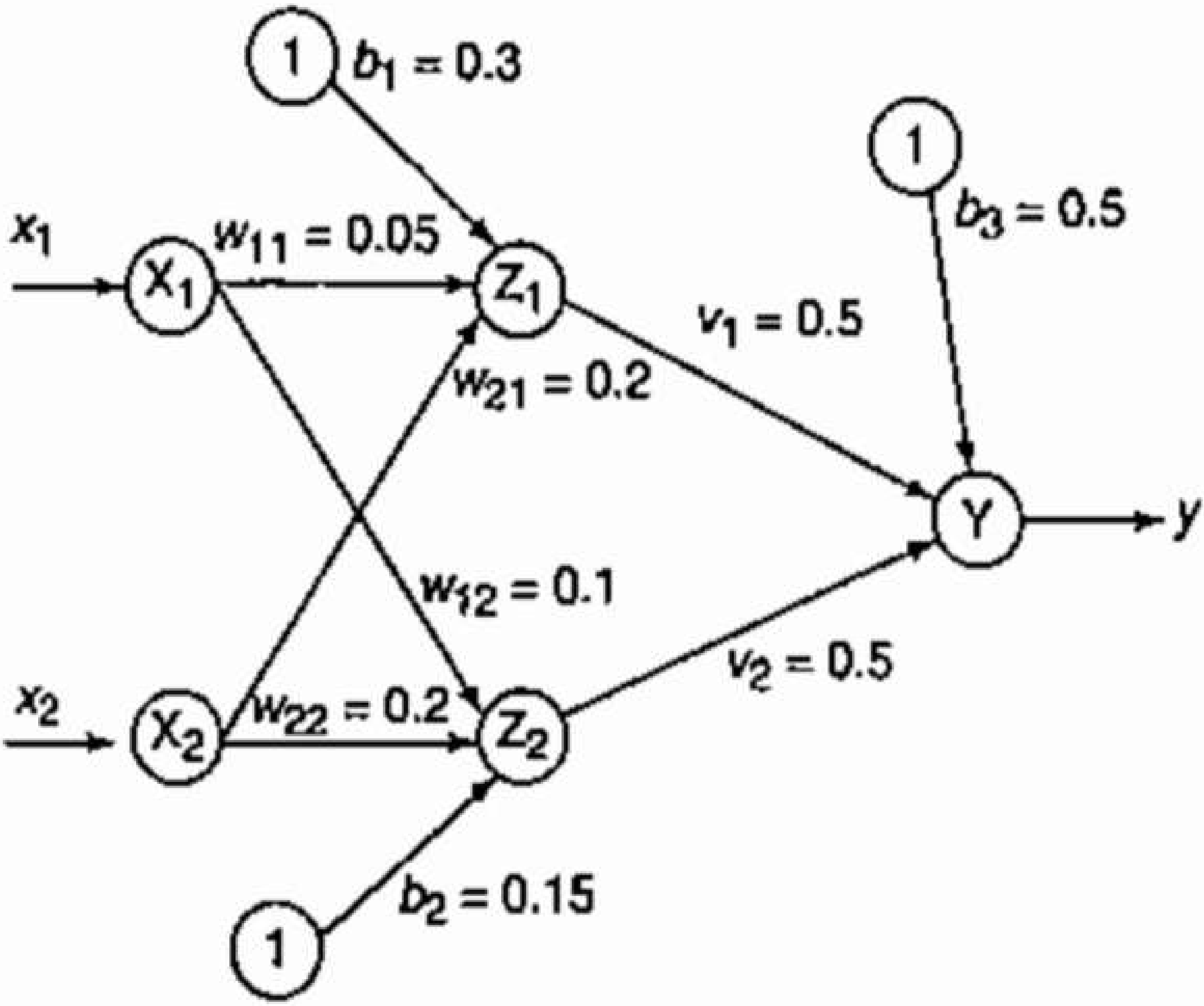
$$y = f(y_{in}) = f(1.5) = 1$$

$$w_{ij}(\text{new}) = w_{ij}(\text{old}) + \alpha(t - z_{\text{in}j})x_i$$
$$b_j(\text{new}) = b_j(\text{old}) + \alpha(t - z_{\text{in}j})$$

This implies:

$$w_{11}(\text{new}) = w_{11}(\text{old}) + \alpha(t - z_{\text{in}1})x_1$$
$$= 0.05 + 0.5(-1 - 0.55) \times 1 = -0.725$$
$$w_{12}(\text{new}) = w_{12}(\text{old}) + \alpha(t - z_{\text{in}2})x_1$$
$$= 0.1 + 0.5(-1 - 0.45) \times 1 = -0.625$$
$$b_1(\text{new}) = b_1(\text{old}) + \alpha(t - z_{\text{in}1})$$
$$= 0.3 + 0.5(-1 - 0.55) = -0.475$$

$$w_{21}(\text{new}) = w_{21}(\text{old}) + \alpha(t - z_{\text{in}1})x_2$$
$$= 0.2 + 0.5(-1 - 0.55) \times 1 = -0.575$$
$$w_{22}(\text{new}) = w_{22}(\text{old}) + \alpha(t - z_{\text{in}2})x_2$$
$$= 0.2 + 0.5(-1 - 0.45) \times 1 = -0.525$$
$$b_2(\text{new}) = b_2(\text{old}) + \alpha(t - z_{\text{in}2})$$
$$= 0.15 + 0.5(-1 - 0.45) = -0.575$$


1
$b_1 = 0.3$
1
$b_3 = 0.5$
x_1
$w_{11} = 0.05$
X_1
Z_1
$v_1 = 0.5$
$w_{21} = 0.2$
Y
y
$w_{12} = 0.1$
$v_2 = 0.5$
x_2
X_2
$w_{22} = 0.2$
Z_2
$b_2 = 0.15$
1