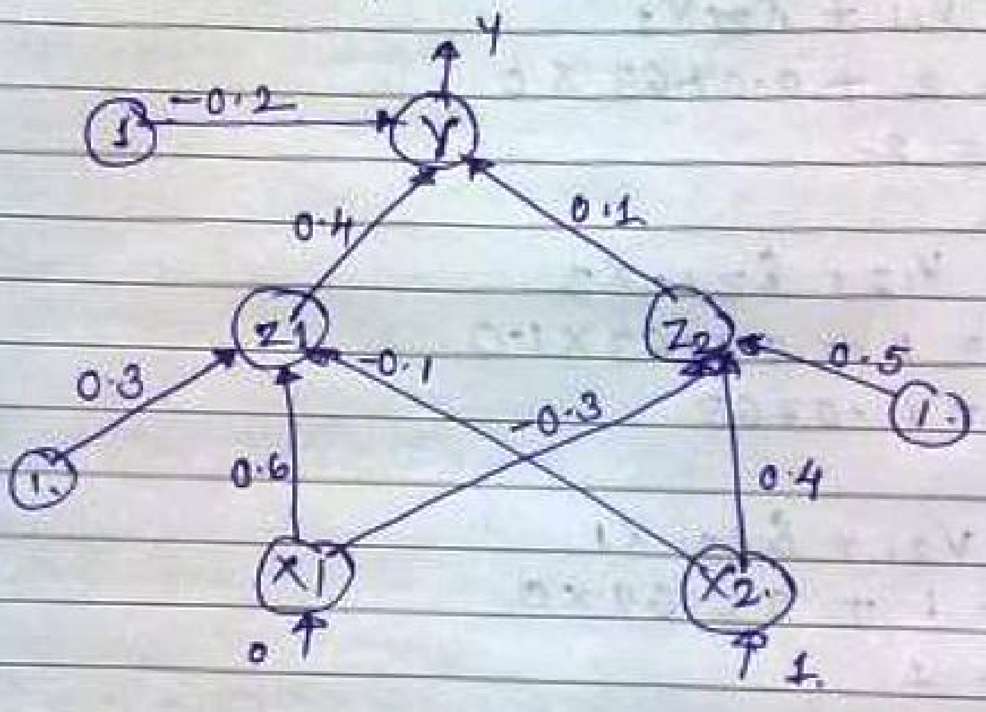
1) Using back propogation network, find the new weights for the net shown in figure. It is presented with the input pattern [0, 1]. and the target output is 1. Use learning rate $\alpha = 0.25$ and binary sigmoidal activation function.



Solution! -

$[v_{11}, v_{12}, v_{01}] = [0.6, -0.1, 0.3]$

$[v_{21}, v_{22}, v_{02}] = [-0.3, 0.4, 0.5]$

$[w_1, w_2, w_0] = [0.4, 0.1, -0.2]$

$\alpha = 0.25, \quad t = 1, \quad \lambda = 1$

Activation function = binary sigmoidal.

$$\therefore f(x) = \frac{1}{1 + e^{-\lambda net}}$$

Calculate the input net for z_1

$$Z_{in1} = x_1 \times V_{11} + x_2 \times V_{12} + 0.3$$
$$= 0 \times 0.6 + 1 \times -0.1 + 0.3$$
$$= 0.2$$

$$Z_{in2} = x_1 \times V_{21} + x_2 \times V_{22} + 0.5$$
$$= 0 \times -0.3 + 1 \times 0.4 + 0.5$$
$$= 0.9$$

$$z_1 = f(Z_{in1}) = \frac{1}{1+e^{-0.2}} = 0.5498$$

$$z_2 = f(Z_{in2}) = \frac{1}{1+e^{-0.9}} = 0.7109$$

$$y_{in} = z_1 \times w_1 + z_2 \times w_2 + w_0$$
$$= 0.5498 \times 0.4 + 0.7109 \times 0.1 + (-0.2)$$
$$= 0.09101$$

$$y = f(y_{in}) = \frac{1}{1+e^{-0.09101}} = 0.5227$$

Compute error term

$$\delta_K = (t_K - y_K) \cdot f'(y_{ink})$$
$$f'(y_{ink}) = f(y_{in})\,[1 - f(y_{in})]$$
$$= 0.5227 \cdot [1 - 0.5227]$$
$$= 0.2495$$
$$\delta_0 = (1 - 0.5227) \cdot \times 0.2495$$
$$= 0.1191$$

Find the changes in weights between hidden and output layer.

Δ $w_1 new = w_1 old + \eta \, \delta o z_1$

$= 0.4 + 0.25 \times 0.1191 \times 0.5498$

$= 0.4 + 0.0164$

$= 0.4164$

$w_2 new = w_2 old + \eta \, \delta o z_2$

$= 0.1 + 0.25 \times 0.1191 \times 0.7109$

$= 0.12117$

Compute error signal terms of hidden layer

$$\delta y_j = y_j (1 - y_j) \cdot \sum_{k=1}^{K} \delta o_k \cdot w_{kj}$$

Two ~~hidden~~ nodes in hidden layer, z_1, z_2

$\delta z_1 = [0.5498 \times (1 - 0.5498)] \times 0.1191 \times 0.4$

$= 0.2475 \times 0.1191 \times 0.4$

$= 0.2475 \times 0.04764$

$= 0.0118$

$\delta z_2 = [0.7109 \times (1 - 0.7109)] \times 0.1191 \times 0.1$

$= 0.2055 \times 0.1191 \times 0.1$

$= 0.00245$

Adjust weights of hidden layer

$v \leftarrow v + \eta \, \delta y \cdot z$

$v_{11} = v_{11} + \eta \cdot \delta z_1 \cdot x_1$
$= 0.6 + 0.25 \times 0.0118 \times 0$
$= 0.6$

$v_{12} = v_{12} + \eta \times \delta z_1 \times x_2$
$= -0.1 + 0.25 \times 0.0118 \times 1$
$= -0.1 + 0.00295$
$= -0.09705$

$v_{21} = v_{21} + \eta \times \delta z_2 \times x_1$
$= -0.3 + 0.25 \times 0.00245 \times 0$
$= -0.3$

$v_{22} = v_{22} + \eta \times \delta z_2 \times x_2$
$= 0.4 + 0.25 \times 0.00245 \times 1$
$= 0.4006125$

Update bias

$v_{01} = v_{01} + \eta \cdot \delta z_1$
$= 0.3 + 0.25 \times 0.0118$
$= 0.3 + 0.00295$
$= 0.30295$

$v_{02} = v_{02} + \eta \cdot \delta z_2$
$= 0.5 + 0.25 \times 0.00245$
$= 0.5006125$

$w_0 = w_0 + \eta \cdot \delta_0$
$= -0.2 + 0.25 \times 0.1191$
$= -0.17022$

Unipolar contineous

$$f(net) = \frac{1}{1+exp(-\lambda net)}$$

$$\delta o_K = (d_K - o_K)(1 - o_K) o_K \cdot \quad for\ k = 1 \cdots k$$

$$\delta y_j = y_j(1 - y_j) \cdot \sum_{K=1}^{K} \delta o_K \cdot w_{Kj} \quad for\ j = 1 \cdots J$$

Bipolar contineous

$$f(net) = \frac{2}{1+exp^{-\lambda net}} - 1$$

$$\delta o_K = \frac{1}{2}(d_K - o_K)(1 - o_K^2) \quad for\ k = 1 \cdots k$$

$$\delta y_j = \frac{1}{2}(1 - y_j^2) \sum_{K=1}^{K} \delta o_K \cdot w_{Kj} \cdot \quad for\ j = 1 \cdots j$$