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Question 1

$$\begin{bmatrix}5\\-1\\2\end{bmatrix}^T \begin{bmatrix}1\\1\\-1\end{bmatrix} = 2 \quad \phi(2) = 2$$

$w^T \; x$

$$\begin{bmatrix}2\\-0.1\\-0.5\end{bmatrix}^T \begin{bmatrix}1\\-1\\1\end{bmatrix} = 1.6 \quad \phi(1.6) = 1.6$$

$$\phi\left(\begin{bmatrix}0\\+0.5\\-0.7\end{bmatrix}^T \begin{bmatrix}1\\2\\1.6\end{bmatrix}\right) = \phi(0(1) + 0.5(2) + -0.7(1.6))$$
$$= \phi(0 + 1 + -1.12)$$
$$= \phi(-0.12) = 0 \therefore y_0 = 0$$

$$\begin{bmatrix}5\\-1\\2\end{bmatrix}^T \begin{bmatrix}1\\-2\\-3\end{bmatrix} = 1 \quad \phi(1) = 1$$

$$\begin{bmatrix}2\\-0.1\\-0.5\end{bmatrix}^T \begin{bmatrix}1\\-3\\-2\end{bmatrix} = 3.3 \quad \phi(3.3) = 3.3$$

$$\phi\left(\begin{bmatrix}0\\0.5\\-0.7\end{bmatrix}^T \begin{bmatrix}1\\1\\3.3\end{bmatrix}\right) = \phi(0(1) + 0.5(1) + -0.7(3.3))$$
$$= \phi(0 + 0.5 + -2.31)$$
$$= \phi(-1.81) = 0 \therefore y_1 = 0$$

$$\begin{bmatrix}5\\-1\\2\end{bmatrix}^T \begin{bmatrix}1\\-5\\-1\end{bmatrix} = 8 \quad \phi(8) = 8$$

$$\begin{bmatrix}2\\-0.1\\-0.5\end{bmatrix}^T \begin{bmatrix}1\\-1\\-5\end{bmatrix} = 4.6 \quad \phi(4.6) = 4.6$$

$$\phi\left(\begin{bmatrix}0\\0.5\\-0.7\end{bmatrix}^T \begin{bmatrix}1\\8\\4.6\end{bmatrix}\right) = \phi(0(1) + 0.5(8) + -0.7(4.6))$$
$$= \phi(0 + 4 + -3.22)$$
$$= \phi(0.78) = 0.78 \therefore y_2 = 0.78$$

$$\begin{bmatrix}5\\-1\\2\end{bmatrix}^T \begin{bmatrix}1\\-2\\2\end{bmatrix} = 11 \quad \phi(11) = 11$$

$$\begin{bmatrix}2\\-0.1\\-0.5\end{bmatrix}^T \begin{bmatrix}1\\2\\-2\end{bmatrix} = 2.8 \quad \phi(2.8) = 2.8$$

$$\phi\left(\begin{bmatrix}0\\0.5\\-0.7\end{bmatrix}^T \begin{bmatrix}1\\11\\2.8\end{bmatrix}\right) = \phi(0(1) + 0.5(11) + -0.7(2.8))$$
$$= \phi(3.54) = 3.54 \therefore y_3 = 3.54$$

DP

$$\begin{bmatrix}5\\-1\\2\end{bmatrix}^T \begin{bmatrix}1\\6\\-2\end{bmatrix} = -5 \quad \phi(-5) = 0$$

$$\phi\left(\begin{bmatrix}0\\0.5\\-0.7\end{bmatrix}^T \begin{bmatrix}1\\0\\6\end{bmatrix}\right) = \phi(0) = 0 \quad \therefore y_4 = 0$$

$$\begin{bmatrix}2\\-0.1\\-0.5\end{bmatrix}^T \begin{bmatrix}1\\-2\\6\end{bmatrix} = -0.8 \quad \phi(-0.8) = 0$$

$$\phi\left(\begin{bmatrix}0\\0.5\\-0.7\end{bmatrix}^T \begin{bmatrix}1\\7\\6\end{bmatrix}\right) = \phi(3.5) = 3.5 \quad \therefore y_5 = 3.5$$

$$\begin{bmatrix}5\\-1\\2\end{bmatrix}^T \begin{bmatrix}1\\4\\3\end{bmatrix} = 7 \quad \phi(7) = 7$$

$$\begin{bmatrix}2\\-0.1\\-0.5\end{bmatrix}^T \begin{bmatrix}1\\3\\4\end{bmatrix} = -0.3 \quad \phi(-0.3) = 0$$

$$\therefore \text{output vector } y = \begin{bmatrix}0\\0\\0.78\\3.54\\0\\3.5\end{bmatrix}$$

DP

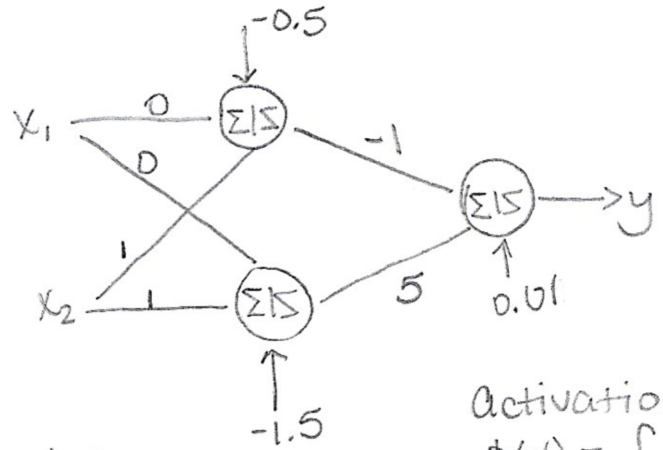
Question 2

Neuron 1

$x_2 - 0.5 = 0$

Neuron 2

$x_2 - 1.5 = 0$




Activation Function

$$\phi(v) = \begin{cases} v & v > 0 \\ 0 & \text{otherwise} \end{cases}$$

Verification using data points

[0, 1] $\begin{bmatrix} -0.5 \\ 0 \\ 1 \end{bmatrix}^T \begin{bmatrix} 1 \\ 0 \\ 1 \end{bmatrix} = 0.5 \Rightarrow N_1 = 0.5$ → since data point needs to be classify as low, weight of $N_1$ of output needs to negative since using ReLu as activation function

$\begin{bmatrix} -1.5 \\ 0 \\ 1 \end{bmatrix}^T \begin{bmatrix} 1 \\ 0 \\ 1 \end{bmatrix} = -0.5 \Downarrow N_2 = 0$

[1, 2] $\begin{bmatrix} -0.5 \\ 0 \\ 1 \end{bmatrix}^T \begin{bmatrix} 1 \\ 1 \\ 2 \end{bmatrix} = 1.5 \Rightarrow N_1 = 1.5$

$\begin{bmatrix} -1.5 \\ 0 \\ 1 \end{bmatrix}^T \begin{bmatrix} 1 \\ 1 \\ 2 \end{bmatrix} = 0.5 \Rightarrow N_2 = 0.5$ → since data point needs to be classify as high and the weight of $N_1$ is negative, the weight of $N_2$ needs to be positive and high enough to overcome the weight of $N_1$

Now, let's verify using inputs {[2, 1], [1, 0]}

[2, 1] ↓ should be classify as low

$\begin{bmatrix} -0.5 \\ 0 \\ 1 \end{bmatrix}^T \begin{bmatrix} 1 \\ 2 \\ 1 \end{bmatrix} = 0.5 \Rightarrow N_1 = 0.5$ $\begin{bmatrix} 0 \\ -1 \\ 5 \end{bmatrix}^T \begin{bmatrix} 1 \\ 0.5 \\ 0 \end{bmatrix} = -0.5 \Rightarrow 0$ ✓

$\begin{bmatrix} -1.5 \\ 0 \\ 1 \end{bmatrix}^T \begin{bmatrix} 1 \\ 2 \\ 1 \end{bmatrix} = -0.5 \Rightarrow N_2 = 0$

[1, 0] ↓ should be classify as high

$\begin{bmatrix} -0.5 \\ 0 \\ 1 \end{bmatrix}^T \begin{bmatrix} 1 \\ 1 \\ 0 \end{bmatrix} = -0.5 \Rightarrow N_1 = 0$ $\begin{bmatrix} 0 \\ -1 \\ 5 \end{bmatrix}^T \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix} = 0$ X → wrong

↳ will add a bias of 0.01 because data points below $x_2 = 0.5$ should be classify as high

$\begin{bmatrix} -1.5 \\ 0 \\ 1 \end{bmatrix}^T \begin{bmatrix} 1 \\ 1 \\ 0 \end{bmatrix} = -1.5 \Rightarrow N_2 = 0$

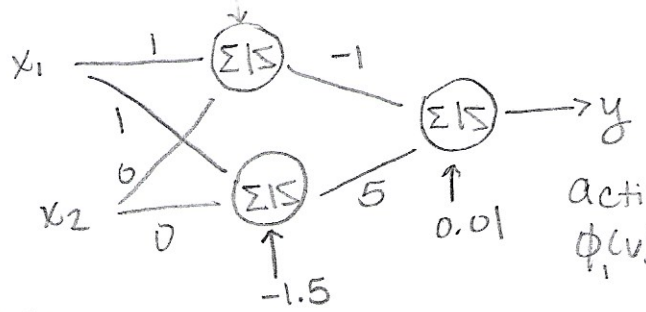
DP

Neuron 1

$x_1 - 0.5 = 0$

Neuron 2

$x_1 - 1.5 = 0$




Activation Function

$$\phi_1(v) = \begin{cases} v & v > 0 \\ 0 & \text{otherwise} \end{cases}$$

$$\phi_2(v) = \begin{cases} 1 & v > 0 \\ 0 & \text{otherwise} \end{cases}$$

Verification using data points

[1,0] $\begin{bmatrix} -0.5 \\ 1 \\ 0 \end{bmatrix}^T \begin{bmatrix} 1 \\ 1 \\ 0 \end{bmatrix} = 0.5 \Rightarrow N_1 = 0.5$ ~> since data point needs to be classify as low, weight of $N_1$ of output layer needs to be negative since using ReLu as the activation function

$\begin{bmatrix} -1.5 \\ 1 \\ 0 \end{bmatrix}^T \begin{bmatrix} 1 \\ 1 \\ 0 \end{bmatrix} = -0.5 \Rightarrow N_2 = 0$

[2,1] $\begin{bmatrix} -0.5 \\ 1 \\ 0 \end{bmatrix}^T \begin{bmatrix} 1 \\ 2 \\ 1 \end{bmatrix} = 1.5 \Rightarrow N_1 = 1.5$

$\begin{bmatrix} -1.5 \\ 1 \\ 0 \end{bmatrix}^T \begin{bmatrix} 1 \\ 2 \\ 1 \end{bmatrix} = 0.5 \Rightarrow N_2 = 0.5$ ~> since data point needs to be classify as high and the weight of $N_1$ is negative the weight of $N_2$ needs to be positive and high enough to overcome the weig of $N_1$

Now, let's verify using inputs {[1,2], [0,1]}

[1,2] ↓ should be classify as low

$\begin{bmatrix} -0.5 \\ 1 \\ 0 \end{bmatrix}^T \begin{bmatrix} 1 \\ 1 \\ 2 \end{bmatrix} = 0.5 \Rightarrow N_1 = 0.5$

$\begin{bmatrix} 0 \\ -1 \\ 5 \end{bmatrix}^T \begin{bmatrix} 1 \\ 0.5 \\ 0 \end{bmatrix} = -0.5 \Rightarrow y = 0$ ✓

$\begin{bmatrix} -1.5 \\ 1 \\ 0 \end{bmatrix}^T \begin{bmatrix} 1 \\ 1 \\ 2 \end{bmatrix} = -0.5 \Rightarrow N_2 = 0$

[0,1] ↓ should be classify as high

$\begin{bmatrix} -0.5 \\ 1 \\ 0 \end{bmatrix}^T \begin{bmatrix} 1 \\ 0 \\ 1 \end{bmatrix} = -0.5 \Rightarrow N_1 = 0$

$\begin{bmatrix} 0 \\ -1 \\ 5 \end{bmatrix}^T \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix} = 0 \Rightarrow y = 0$ X ↓ should be classify as 1

~> will add small bias to classify data points to the left of $x_1 = 0.5$ boundary as 1

$\begin{bmatrix} -1.5 \\ 1 \\ 0 \end{bmatrix}^T \begin{bmatrix} 1 \\ 0 \\ 1 \end{bmatrix} = -1.5 \Rightarrow N_2 = 0$

DP

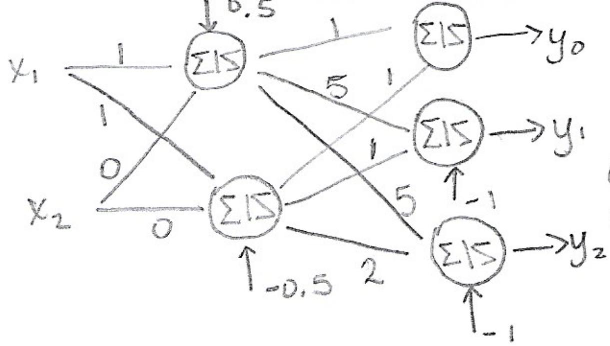
Data Set 2

Neuron 1

$x_1 + 0.5 = 0$

Neuron 2

$x_1 - 0.5 = 0$




Activation Functions

$\phi_1(v) = \begin{cases} v & v > 0 \\ 0 & \text{otherwise} \end{cases}$

$\phi_2(v) = \dfrac{e^{v_i}}{\sum e^{v_i}}$ (Softmax Function)

[-1, 0] ↓ should be classify as class 0 $\therefore p_0 > p_1, p_2$

$\begin{bmatrix} 0.5 \\ 1 \\ 0 \end{bmatrix}^T \begin{bmatrix} 1 \\ -1 \\ 0 \end{bmatrix} = -0.5 \Rightarrow N_1 = 0$

$\begin{bmatrix} -0.5 \\ 1 \\ 0 \end{bmatrix}^T \begin{bmatrix} 1 \\ -1 \\ 0 \end{bmatrix} = -1.5 \Rightarrow N_2 = 0$

→ since this data point needs to be classify as 0, and $N_1$ and $N_2$ are 0, the bias for the last 2 neurons of the output layers would need to be negative for $p_0$ to be > $p_1, p_2$

[0, 1] ↓ should be classify as class 1 $\therefore p_1 > p_0, p_2$

$\begin{bmatrix} 0.5 \\ 1 \\ 0 \end{bmatrix}^T \begin{bmatrix} 1 \\ 0 \\ 1 \end{bmatrix} = 0.5 \Rightarrow N_1 = 0.5$

$\begin{bmatrix} -0.5 \\ 1 \\ 0 \end{bmatrix}^T \begin{bmatrix} 1 \\ 0 \\ 1 \end{bmatrix} = -0.5 \Rightarrow N_2 = 0$

→ since data point needs to be classif[y] as 1 and the bias of middle neuron i[s] negative, the weight of middle neu[ron] for $N_1$ needs to be positive and high enough to overcome the bias

[1, 0] ↓ should be classify as class 2 $\therefore p_2 > p_0, p_1$

$\begin{bmatrix} 0.5 \\ 1 \\ 0 \end{bmatrix}^T \begin{bmatrix} 1 \\ 1 \\ 0 \end{bmatrix} = 1.5 \Rightarrow N_1 = 1.5$

$\begin{bmatrix} -0.5 \\ 1 \\ 0 \end{bmatrix}^T \begin{bmatrix} 1 \\ 1 \\ 0 \end{bmatrix} = 0.5 \Rightarrow N_2 = 0.5$

→ since data point needs to be classif[y] as 2, the weight of $N_1$ or $N_2$ of the last neuron needs to be positi[ve] and high enough to overcome the weights of the 1st and 2nd neurons

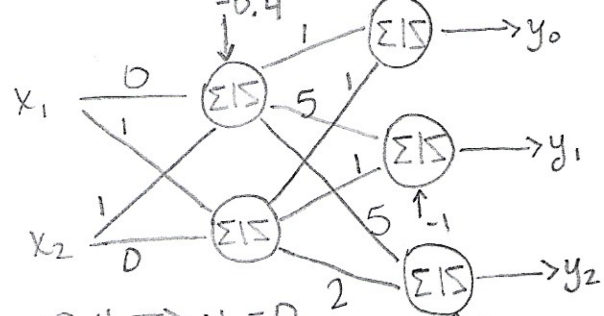
DP

Neuron 1

$X_2 - 0.4 = 0$

Neuron 2

$X_1 - 0 = 0$




Activation Functions

$\phi_1(v) = \begin{cases} v & v > 0 \\ 0 & \text{otherwise} \end{cases}$

$\phi_2(v) = \dfrac{e^{v_i}}{\sum e^{v_i}}$ (softmax function)

[-1, 0] ↓ should be classify as class 0 ∴ $p_0 > p_1, p_2$

$\begin{bmatrix}-0.4\\0\\1\end{bmatrix}^T \begin{bmatrix}1\\-1\\0\end{bmatrix} = -0.4 \Rightarrow N_1 = 0$

$\begin{bmatrix}0\\1\\0\end{bmatrix}^T \begin{bmatrix}1\\-1\\0\end{bmatrix} = -1 \Rightarrow N_2 = 0$

→ since this data point needs to be classify as 0 and $N_1$ and $N_2$ are 0, the bias for the last 2 neurons of the output layer need to be negative so that $p_0 > p_1, p_2$

[0, 1] ↓ should be classify as class 1 ∴ $p_1 > p_0, p_2$

$\begin{bmatrix}-0.4\\0\\1\end{bmatrix}^T \begin{bmatrix}1\\0\\1\end{bmatrix} = 0.6 \Rightarrow N_1 = 0.6$ → since data point needs to be classify as 1 and the bias of the middle neuron is negative, the weight of the middle neuron for $N_1$ needs to be positive and high enough to overcome its bias and the weights of the 1st and 3rd neurons in the output layer so $p_1 > p_0, p_2$

$\begin{bmatrix}0\\1\\0\end{bmatrix}^T \begin{bmatrix}1\\0\\1\end{bmatrix} = 0 \Rightarrow N_2 = 0$

[1, 0] ↓ should be classify as class 2 ∴ $p_2 > p_0, p_1$

$\begin{bmatrix}-0.4\\0\\1\end{bmatrix}^T \begin{bmatrix}1\\1\\0\end{bmatrix} = -0.4 \Rightarrow N_1 = 0$

$\begin{bmatrix}0\\1\\0\end{bmatrix}^T \begin{bmatrix}1\\1\\0\end{bmatrix} = 1 \Rightarrow N_2 = 1$ → since data point needs to be classify as 2, the weight of either $N_1$ or $N_2$ needs to be positive and high enough to overcome $p_0$ and $p_1$

Verification

[0.25, 1] ↓ should be classify as class 1 ∴ $p_1 > p_0, p_2$

$\begin{bmatrix}-0.4\\0\\1\end{bmatrix}^T \begin{bmatrix}1\\0.25\\1\end{bmatrix} = 0.6 \Rightarrow N_1 = 0.6$

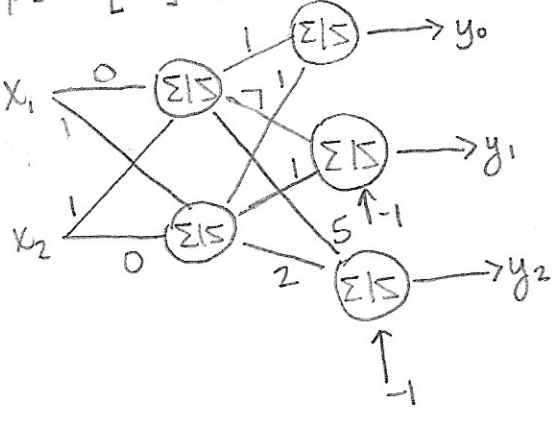
$\begin{bmatrix}0\\1\\0\end{bmatrix}^T \begin{bmatrix}1\\0.25\\1\end{bmatrix} = 0.25 \Rightarrow N_2 = 0.25$

$\begin{bmatrix}0\\1\\1\end{bmatrix}^T \begin{bmatrix}1\\0.6\\0.25\end{bmatrix} = 0.85$

$\begin{bmatrix}-1\\5\\1\end{bmatrix}^T \begin{bmatrix}1\\0.6\\0.25\end{bmatrix} = 2.25$

$\begin{bmatrix}-1\\5\\2\end{bmatrix}^T \begin{bmatrix}1\\0.6\\0.25\end{bmatrix} = 2.5$ X

↓ should be classify as class 1; therefore the weight of $N_1$ needs to be increased such that $p_1 > p_0, p_2$




weight of $N_1$ for middle neuron changed from 5 to 7

DP

$[0.75, 0]$

should be classify as class 2

$$\begin{bmatrix}-0.4\\0\\1\end{bmatrix}^T\begin{bmatrix}1\\0.75\\0\end{bmatrix} = -0.4 \Rightarrow N_1 = 0$$

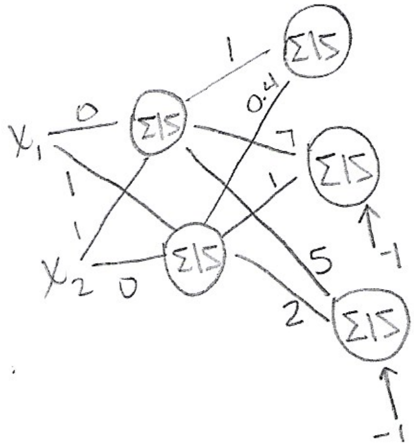
$$\begin{bmatrix}0\\1\\0\end{bmatrix}^T\begin{bmatrix}1\\0.75\\0\end{bmatrix} = 0.75 \Rightarrow N_2 = 0.75$$

$$\begin{bmatrix}0\\1\\1\end{bmatrix}^T\begin{bmatrix}1\\0\\0.75\end{bmatrix} = 0.75$$

$$\begin{bmatrix}-1\\7\\1\end{bmatrix}^T\begin{bmatrix}1\\0\\0.75\end{bmatrix} = -0.25 \Rightarrow y_1 = 0$$

$$\begin{bmatrix}-1\\5\\2\end{bmatrix}^T\begin{bmatrix}1\\0\\0.75\end{bmatrix} = 0.5$$

should be classify as class 2; therefore, the weight of $N_2$ for the first neuron in the output layer needs to be decrease such that $p_2 > p_0, p_1$; weight $N_2$ changed from 1 to 0.4 for the 1st neuron




DP

Data Set 3

Neuron 1

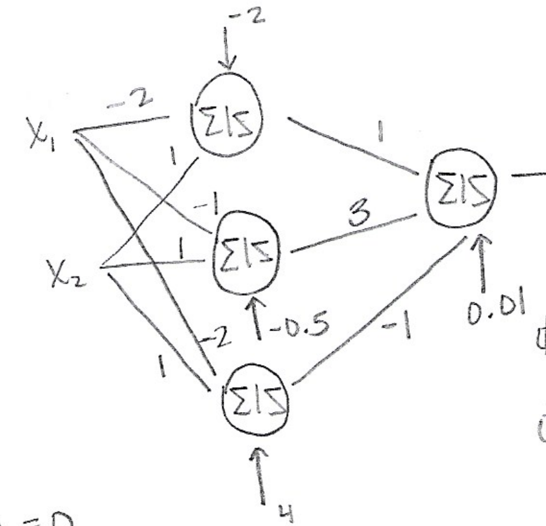
$-2x_1 + x_2 - 2 = 0$

Neuron 2

$-x_1 + x_2 - 0.5 = 0$

Neuron 3

$-1.5x_1 + x_2 + 3 = 0$




Activation Function

$\phi_1(v) = \begin{cases} v & v > 0 \\ 0 & \text{otherwise} \end{cases}$

$\phi_2(v) = \begin{cases} 1 & v > 0 \\ 0 & \text{otherwise} \end{cases}$

[1, 0] ↓ should be classify as class 0

$\begin{bmatrix} -2 \\ -2 \\ 1 \end{bmatrix}^T \begin{bmatrix} 1 \\ 1 \\ 0 \end{bmatrix} = -4 \Rightarrow N_1 = 0$

$\begin{bmatrix} -0.5 \\ -1 \\ 1 \end{bmatrix}^T \begin{bmatrix} 1 \\ 1 \\ 0 \end{bmatrix} = -1.5 \Rightarrow N_2 = 0$

$\begin{bmatrix} 3 \\ -1.5 \\ 1 \end{bmatrix}^T \begin{bmatrix} 1 \\ 1 \\ 0 \end{bmatrix} = 1.5 \Rightarrow N_3 = 1.5$ → since data point needs to be classify as class 0, the weight of $N_3$ needs to be negative so that the activation function will output 0 as its label

[2, 4] ↓ should be classify as class 1

$\begin{bmatrix} -2 \\ -2 \\ 1 \end{bmatrix}^T \begin{bmatrix} 1 \\ 2 \\ 4 \end{bmatrix} = -2 \Rightarrow N_1 = 0$

$\begin{bmatrix} -0.5 \\ -1 \\ 1 \end{bmatrix}^T \begin{bmatrix} 1 \\ 2 \\ 4 \end{bmatrix} = 1.5 \Rightarrow N_2 = 1.5$

$\begin{bmatrix} 3 \\ -1.5 \\ 1 \end{bmatrix}^T \begin{bmatrix} 1 \\ 2 \\ 4 \end{bmatrix} = 4 \Rightarrow N_3 = 4$ → since data point needs to be classify as class 1, the weight of $N_2$ needs to be positive and high enough to overcome the negative weight of $N_3$ to be classify as class 1

[4, 2.5] ↓ should be classify as class 1

$\begin{bmatrix} -2 \\ -2 \\ 1 \end{bmatrix}^T \begin{bmatrix} 1 \\ 4 \\ 2.5 \end{bmatrix} = -7.5 \Rightarrow N_1 = 0$

$\begin{bmatrix} -0.5 \\ -1 \\ 1 \end{bmatrix}^T \begin{bmatrix} 1 \\ 4 \\ 2.5 \end{bmatrix} = -2.5 \Rightarrow N_2 = 0$

$\begin{bmatrix} 3 \\ -1.5 \\ 1 \end{bmatrix}^T \begin{bmatrix} 1 \\ 4 \\ 2.5 \end{bmatrix} = -1.5 \Rightarrow N_3 = 0$ → since data point needs to be classify as class 1, a small bias needs to be added to the output layer so it will be labelled in class 1

DP

[0.75, 5]

↓

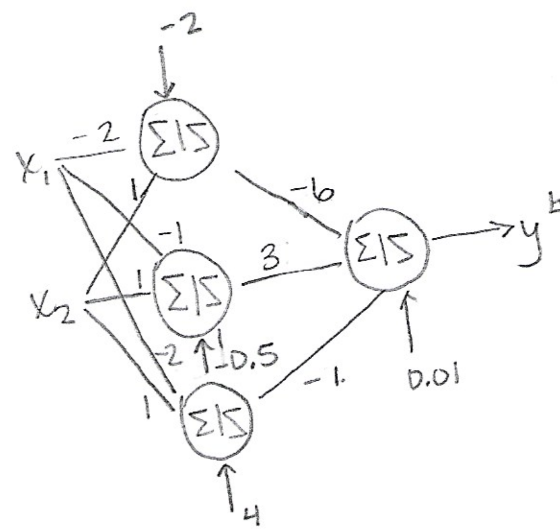
should classify as class 0

$$\begin{bmatrix}-2\\-2\\1\end{bmatrix}^T \begin{bmatrix}1\\0.75\\5\end{bmatrix} = 1.5 \Longrightarrow N_1 = 1.5$$

$$\begin{bmatrix}-0.5\\-1\\1\end{bmatrix} \begin{bmatrix}1\\0.75\\5\end{bmatrix} = 3.75 \Longrightarrow N_2 = 3.75$$

$$\begin{bmatrix}3\\-1.5\\1\end{bmatrix}^T \begin{bmatrix}1\\0.75\\5\end{bmatrix} = 6.875 \Longrightarrow N_2 = 6.875$$

since data point needs to be classify as class 0, the weight of $N_1$ of the output layer needs to have a negative value so the weight of $N_1$ will overcome the weight of $N_2$ to classify data point in class 0; this also avoids changing the weight of $N_3$ that would cause data points between decision boundaries 1 and 2 to be labelled in class 1 instead class 0; therefore ~~the~~ weight of $N_1$ is changed from 1 to -6




DP

Neuron 1

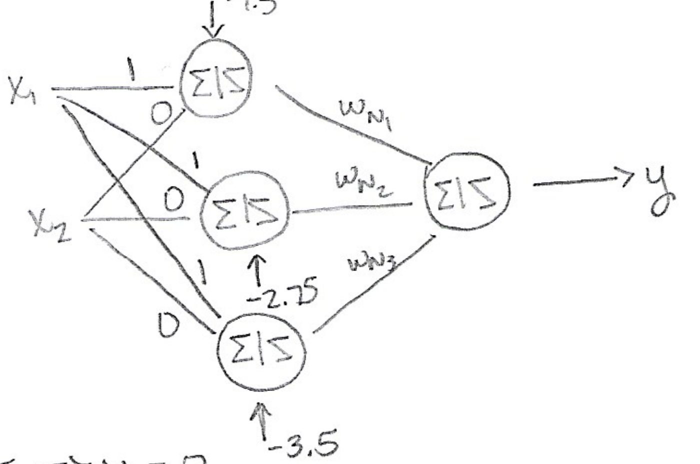
$x_1 - 1.5 = 0$

Neuron 2

$x_1 - 2.75 = 0$

Neuron 3

$x_1 - 3.5 = 0$




Activation Functions

$\phi_1(v) = \begin{cases} v & v > 0 \\ 0 & \text{otherwise} \end{cases}$

$\phi_2(v) = \begin{cases} 1 & v > 0 \\ 0 & \text{otherwise} \end{cases}$

[1, 0] $\downarrow$ should be classify as class 0

$$\begin{bmatrix} -1.5 \\ 1 \\ 0 \end{bmatrix}^T \begin{bmatrix} 1 \\ 1 \\ 0 \end{bmatrix} = -0.5 \Rightarrow N_1 = 0$$

$$\begin{bmatrix} -2.75 \\ 1 \\ 0 \end{bmatrix}^T \begin{bmatrix} 1 \\ 1 \\ 0 \end{bmatrix} = -1.75 \Rightarrow N_2 = 0$$

$$\begin{bmatrix} -3.5 \\ 1 \\ 0 \end{bmatrix}^T \begin{bmatrix} 1 \\ 1 \\ 0 \end{bmatrix} = -2.5 \Rightarrow N_2 = 0$$

will be classified in class 0

[2, 4] $\downarrow$ should be classify as class 1

$$\begin{bmatrix} -1.5 \\ 1 \\ 0 \end{bmatrix}^T \begin{bmatrix} 1 \\ 2 \\ 4 \end{bmatrix} = 0.5 \Rightarrow N_1 = 0.5$$

$\rightarrow$ will be classify as class 1 if weight of $N_1$ is positive

$$\begin{bmatrix} -2.75 \\ 1 \\ 0 \end{bmatrix}^T \begin{bmatrix} 1 \\ 2 \\ 4 \end{bmatrix} = -0.75 \Rightarrow N_2 = 0$$

$$\begin{bmatrix} -3.5 \\ 1 \\ 0 \end{bmatrix}^T \begin{bmatrix} 1 \\ 2 \\ 4 \end{bmatrix} = -1.5 \Rightarrow N_3 = 0$$

[3, 2.5] $\downarrow$ should be classify as class 0

$$\begin{bmatrix} -1.5 \\ 1 \\ 0 \end{bmatrix}^T \begin{bmatrix} 1 \\ 3 \\ 2.5 \end{bmatrix} = 1.5 \Rightarrow N_1 = 1.5$$

$$\begin{bmatrix} -2.75 \\ 1 \\ 0 \end{bmatrix}^T \begin{bmatrix} 1 \\ 3 \\ 2.5 \end{bmatrix} = 0.25 \Rightarrow N_2 = 0.25$$

since data point needs to be classify as class 0, the weight of $N_2$ needs to be a negative value that can overcome the weight of $N_1$

$$\begin{bmatrix} -3.5 \\ 1 \\ 0 \end{bmatrix}^T \begin{bmatrix} 1 \\ 3 \\ 2.5 \end{bmatrix} = -0.5 \Rightarrow N_3 = 0$$

DP

[4, 2.5]

↓

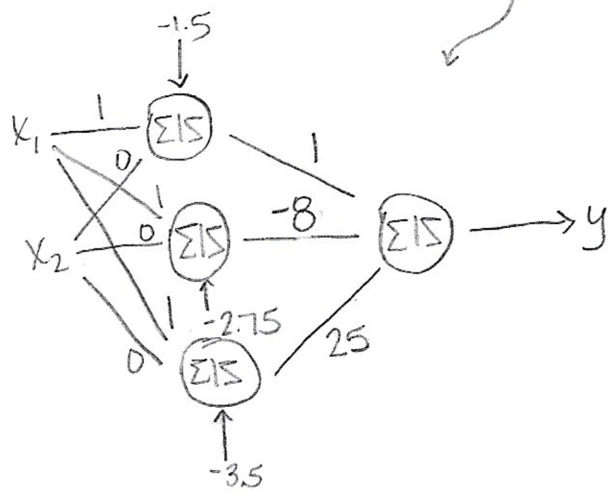
should be classify as class 0

$$\begin{bmatrix} -1.5 \\ 1 \\ 0 \end{bmatrix}^T \begin{bmatrix} 1 \\ 4 \\ 2.5 \end{bmatrix} = 2.5 \Rightarrow N_1 = 2.5$$

$$\begin{bmatrix} -2.75 \\ 1 \\ 0 \end{bmatrix}^T \begin{bmatrix} 1 \\ 4 \\ 2.5 \end{bmatrix} = 1.25 \Rightarrow N_2 = 1.25$$

$$\begin{bmatrix} -3.5 \\ 1 \\ 0 \end{bmatrix}^T \begin{bmatrix} 1 \\ 4 \\ 2.5 \end{bmatrix} = 0.5 \Rightarrow N_3 = 0.5$$

since data point needs to be classify as class 1, the weight of $N_3$ to be positive and high enough to overcome negative weight of $N_2$




DP