

# Assignment 1

## Question 1

$$\text{Equation} = \bar{x}_1 x_2 x_3 + x_1 \bar{x}_2$$

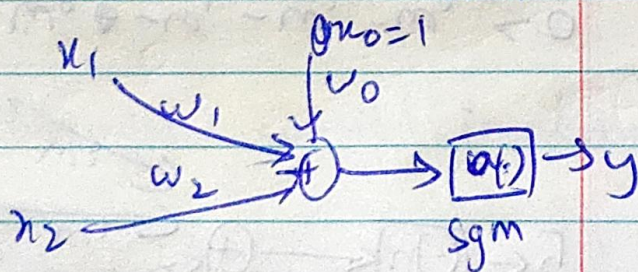
~~$$= \text{OR}(\text{AND}(\text{NOT}(x_1), \text{AND}(x_2, x_3)), \text{AND}(x_1, \text{NOT}(x_2)))$$~~

We need to implement AND, NOT and OR function

$$= \text{OR}(\text{AND}(\text{NOT}(x_1), \text{AND}(x_2, x_3)), \text{AND}(x_1, \text{NOT}(x_2)))$$

~~AND~~ AND:

| $x_1$ | $x_2$ | $y$ |
|-------|-------|-----|
| -1    | -1    | -1  |
| -1    | 1     | -1  |
| 1     | -1    | -1  |
| 1     | 1     | 1   |



$$w_0 + w_1 + w_2 \leq 0$$

$$w_0 - w_1 + w_2 < 0$$

$$w_0 + w_1 - w_2 < 0$$

$$w_0 + w_1 + w_2 > 0$$

~~$$\Rightarrow w_0 < 0, w_1 > 0, w_2 > 0$$~~

$$\Rightarrow w_0 < w_1, w_2 > 0, w_1 > 0$$

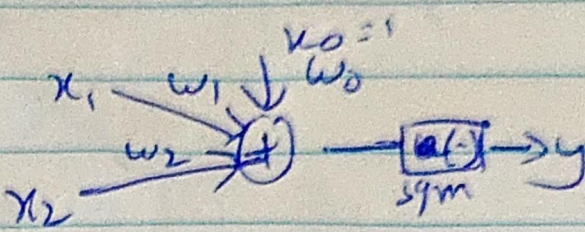
$$w_1 + w_2 > 0$$



$$w_0 = -1, w_1 = 1, w_2 = 1$$

OR

| $x_1$ | $x_2$ | $y$ |
|-------|-------|-----|
| -1    | -1    | -1  |
| 1     | -1    | 1   |
| -1    | 1     | 1   |
| 1     | 1     | 1   |



The diagram shows a neural network with two inputs,  $x_1$  and  $x_2$ , and a bias  $x_0 = 1$ . The weights are  $w_1$  and  $w_2$ . The bias  $w_0$  is also shown. The inputs are multiplied by their respective weights and summed at a node (represented by a circle with a plus sign). The result is then passed through a sigmoid function (represented by a box labeled 'sgm') to produce the output  $y$ .

$$\Rightarrow w_0 > 0$$

~~$$w_0 + w_1 + w_2 > 0$$~~

$$w_1 > 0$$

$$w_2 > 0$$

$$w_0 = 1, w_1 = 1, w_2 = 1$$

$$w_0 - w_1 - w_2 < 0$$

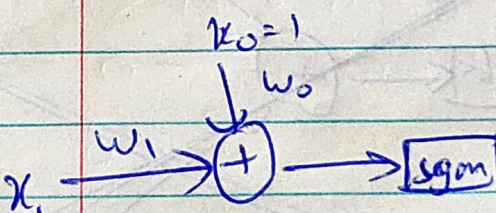
$$w_0 + w_1 - w_2 > 0$$

$$w_0 - w_1 + w_2 > 0$$

$$w_0 + w_1 + w_2 > 0$$

NOT:

| $x_1$ | $y$ |
|-------|-----|
| 1     | -1  |
| -1    | 1   |



The diagram shows a neural network with one input,  $x_1$ , and a bias  $x_0 = 1$ . The weight is  $w_1$ . The bias  $w_0$  is also shown. The input is multiplied by its weight and the bias is added at a node (represented by a circle with a plus sign). The result is then passed through a sigmoid function (represented by a box labeled 'sgm') to produce the output  $y$ .

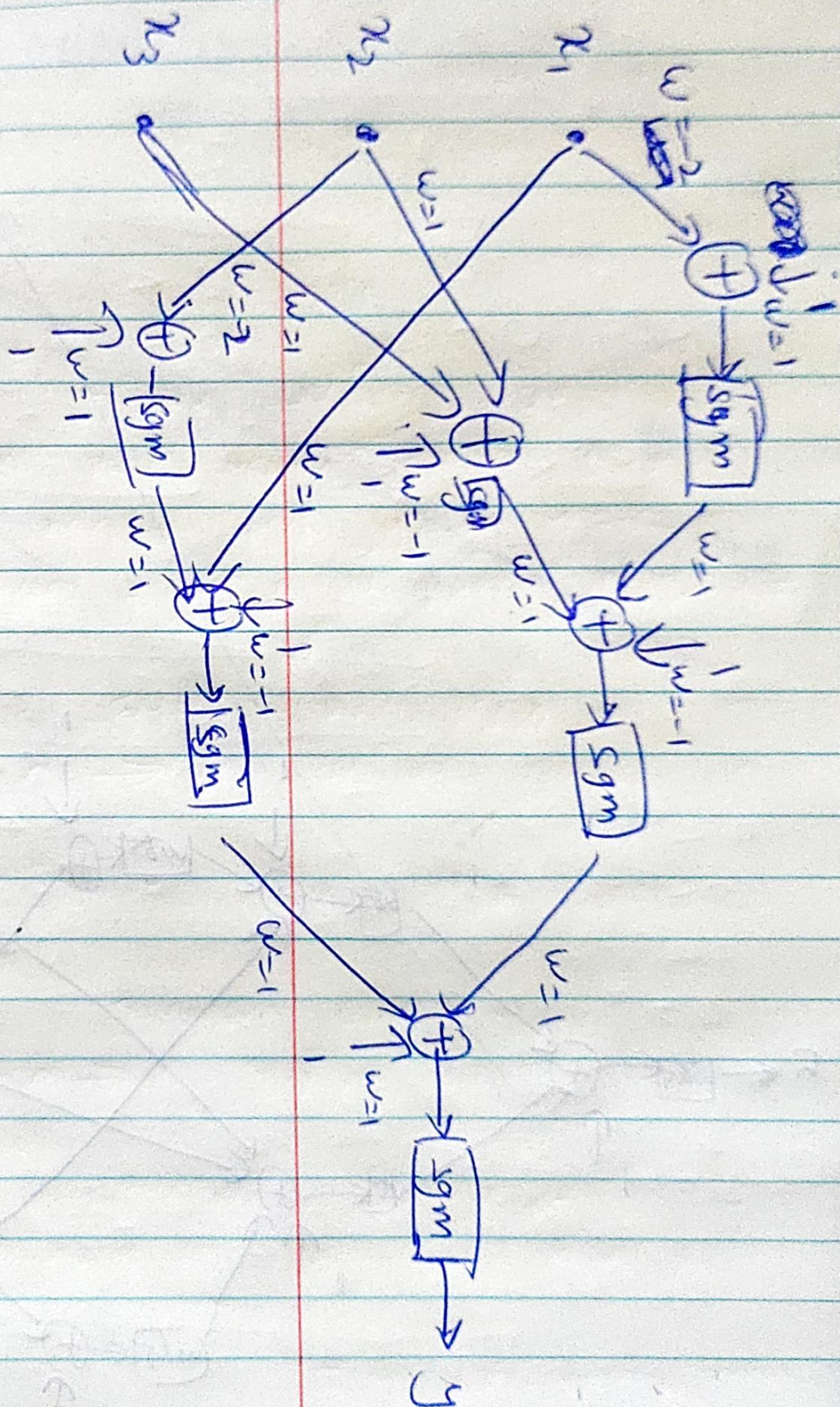
$$w_0 + w_1 < 0$$

$$w_0 - w_1 > 0$$

$$w_1 < 0, w_0 > 0$$

$$w_1 = -2, w_0 = 1$$





Question 2:

Code:

```
import matplotlib as m
import numpy as np
import random as rand
import time
import matplotlib.pyplot as plt

rand.seed(time.time())
coords = np.empty([2, 1000])

for i in range(1000):
    coords[0][i] = rand.uniform(2, -2)
    coords[1][i] = rand.uniform(2, -2)

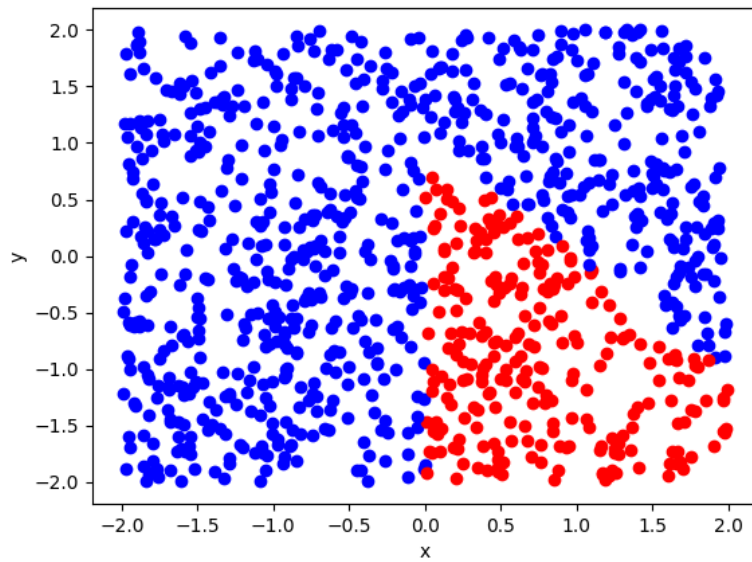
def step(input):
    if input<0:
        return 0
    else:
        return 1

def network(x, y):
    return step(-1.5 + step(1 + x - y) + step(1 - x - y) - step(-x))

for i in range(1000):
    if network(coords[0][i], coords[1][i]) == 0:
        plt.plot(coords[0][i], coords[1][i], 'bo')
    else:
        plt.plot(coords[0][i], coords[1][i], 'ro')
plt.xlabel('x')
plt.ylabel('y')
```

plt.show()

Plot:



The region where the values are 1 are between the lines  $x = 0$  and  $y = -x + 1$

