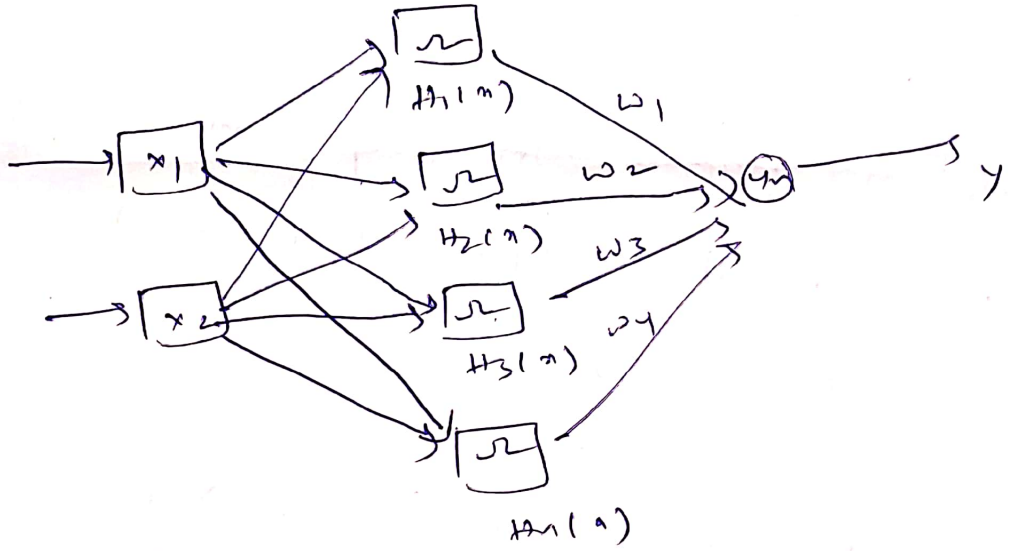
Radial Basis function

Data can be either linearly separable or non linearly separable.

Multilayer Perceptron is required for classifying Non linearly separable data. Can contain any number of hidden layer.

Radial basis function is a type of Multilayer Perceptron which has one input layer, one output layer and with strictly one hidden layer.



The hidden layer uses a non linear radial basis function as the activation function which converts input parameters into higher dimension space which then fed into the network to linearly separate the problem.

If it is 2D we will convert into 3-Dimensional.

The radial basis function is used in

1) Time Series Prediction 2) classification.

There are different types of radial basis functions are available

1) Gaussian RBF

$$H(x) = e^{-\frac{(x-c)^2}{r^2}}.$$

2) Multiquadratic RBF

$$H(x) = \sqrt{\frac{r^2+(x-c)^2}{r}}.$$

Assign weights for every connection from Hidden layer to the output layer in the network in the range $[-1, 1]$.

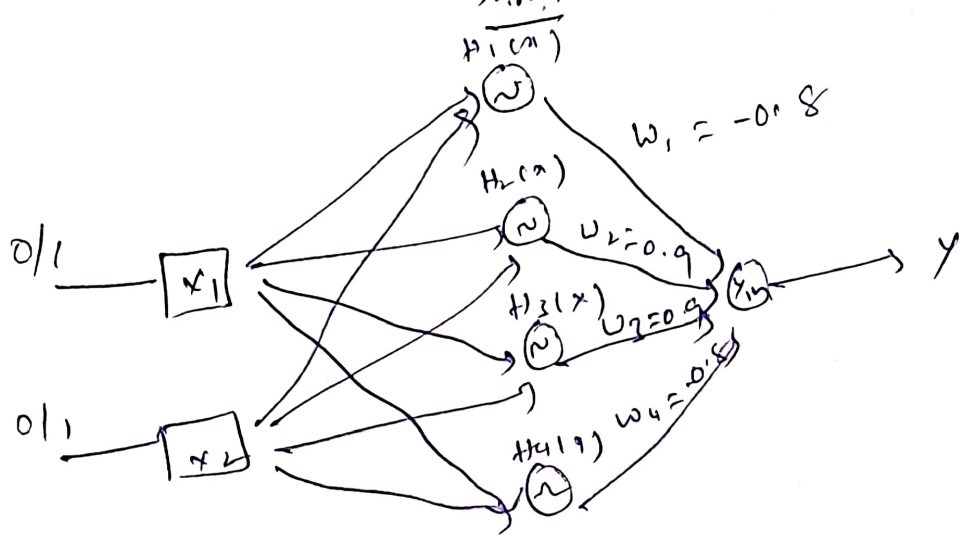
Radial Basis function for Solving XOR.

XOR Boolean function consists of 4 patterns

(0,0) (0,1) (1,0) (1,1).

Radius = 1.414.

Construct RBF that classifies the input pattern.



for Input pattern (0,0)

Distance from (0,0)

$(0-0)^2 + (0-0)^2 = 0$

$e^{-\frac{(0-0)^2}{2}} = e^{-0/2} = 1$

Distance from (0,1)

$(0-0)^2 + (0-1)^2 = 1$

$e^{-\frac{(0-1)^2}{2}} = e^{-1/2} = 0.6$

Distance from (1,0)

$(0-1)^2 + (0-0)^2 = 1$

$e^{-\frac{(0-1)^2}{2}} = e^{-1/2} = 0.6$

Distance from (1,1)

$(0-1)^2 + (0-1)^2 = 2$

$e^{-\frac{(0-2)^2}{2}} = e^{-2/2} = e^{-1} = 0.4$

$= 1x - 0.8 + 0.6 \times 0.9 + 0.6 \times 0.9 + 0.4 \times -0.8$

$= -0.8 + 0.54 + 0.54 - 0.32$

-0.04

Distance from (0,1) for Input pattern (0,1)

Distance from (0,0)

$(0-0)^2 + (0-1)^2 = 0$

$e^{-0/2} = 0.6$

Distance from (0,1)

$(0-0)^2 + (1-1)^2 = 0$

$e^{-0/2} = 1$

Distance from (1,0)

$(0-1)^2 + (1-0)^2 = 2$

$e^{-2/2} = e^{-1} = 0.4$

Distance from (1,1)

$(0-1)^2 + (1-1)^2 =$

$e^{-1/2} = 0.6$

$0.6 \times -0.8 + 1 \times 0.9$

$+ 0.4 * 0.9 +$

$0.6 (-0.8)$

$= -0.48 + 0.9 + 0.36 - 0.48$

$= 0.3$

For input pattern (1,0)

Distance from (0,0)

$= 0.6$

from (0,1)

$= 0.4$

from (1,0)

$= 1.0$

from (1,1)

$= 0.6$

$= -0.8 \times 0.6 + 0.9 \times 0.4 + 0.9 \times 1 + (-0.8) \times 0.6$

$= 0.3$

For input pattern (1,1)

Distance from (0,0)

0.4

from (0,1)

0.6

from (1,0)

0.6

from (1,1)

1.0

$= -0.8 \times 0.4 + 0.9 \times 0.6 + 0.9 \times 0.6 + 1 \times (0.8)$

$= -0.32 + 0.54 + 0.54 - 0.8$

$= -0.04$

Input		Hidden				o/p y_n		
x_1	x_2	H_1	H_2	H_3	H_4			
0	0	1.0	0.6	0.6	0.4	-0.04	≤ 0	0
0	1	0.6	1.0	0.4	0.6	0.3	> 0	1
1	0	0.6	0.4	1.0	0.6	0.3	> 0	1
1	1	0.4	0.6	0.6	1.0	-0.04	< 0	0