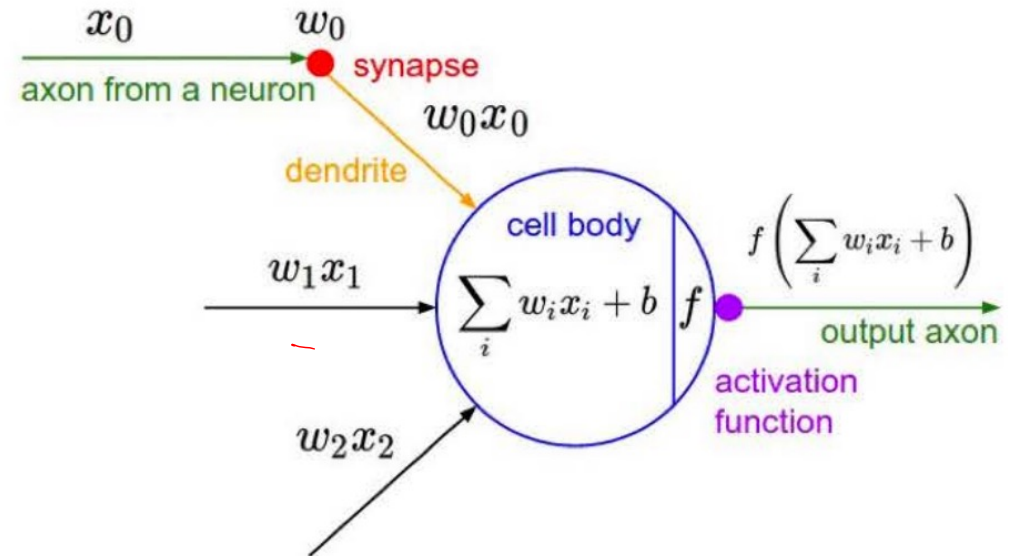
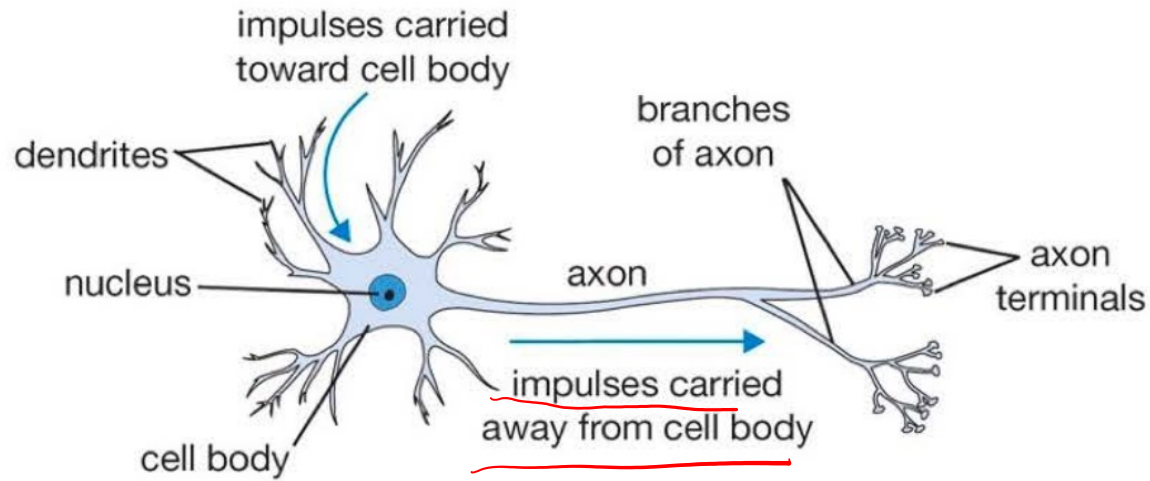




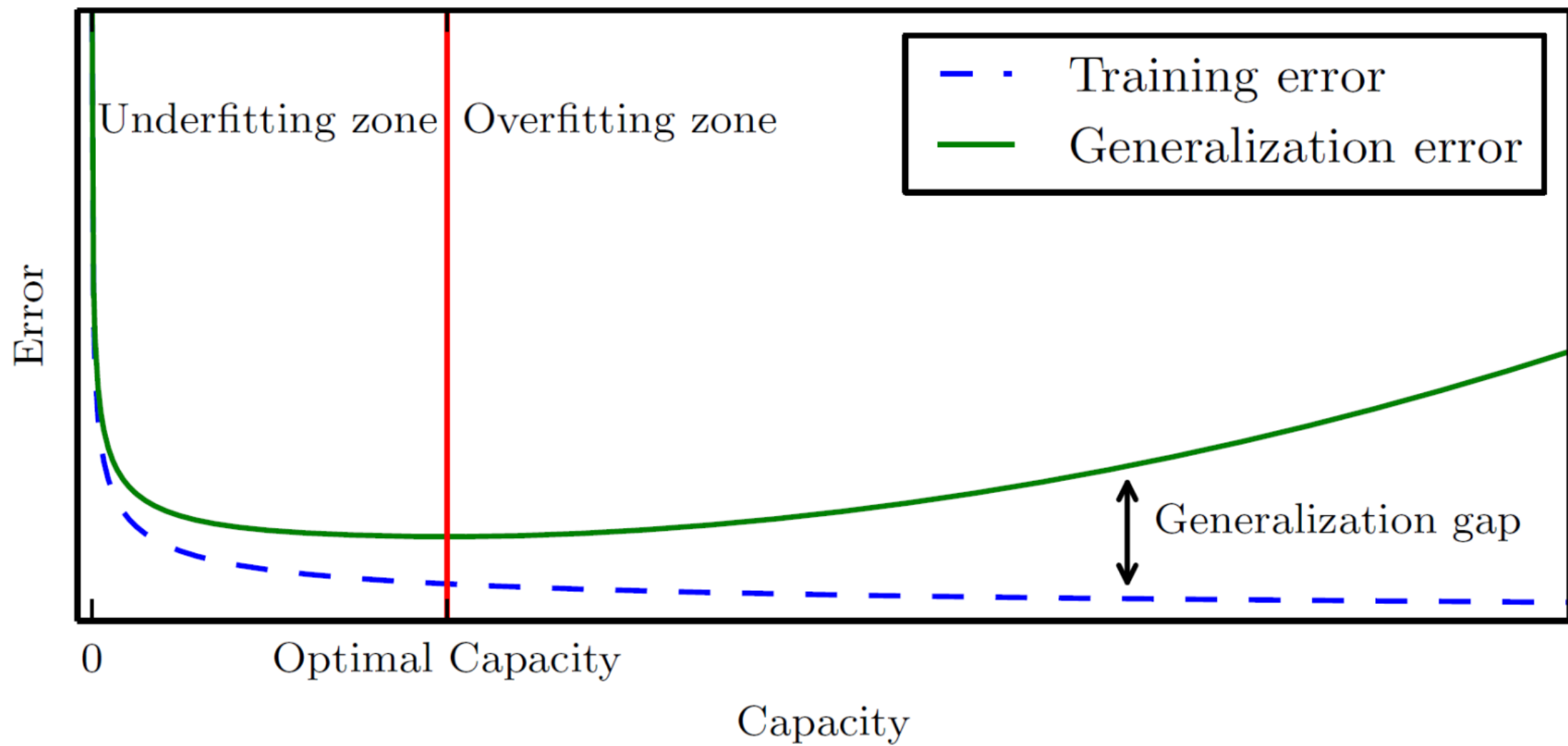
# FUNDAMENTALS ABOUT NEURAL NETWORK



# Brain inspired computing



i/p  $\rightarrow$  o/p



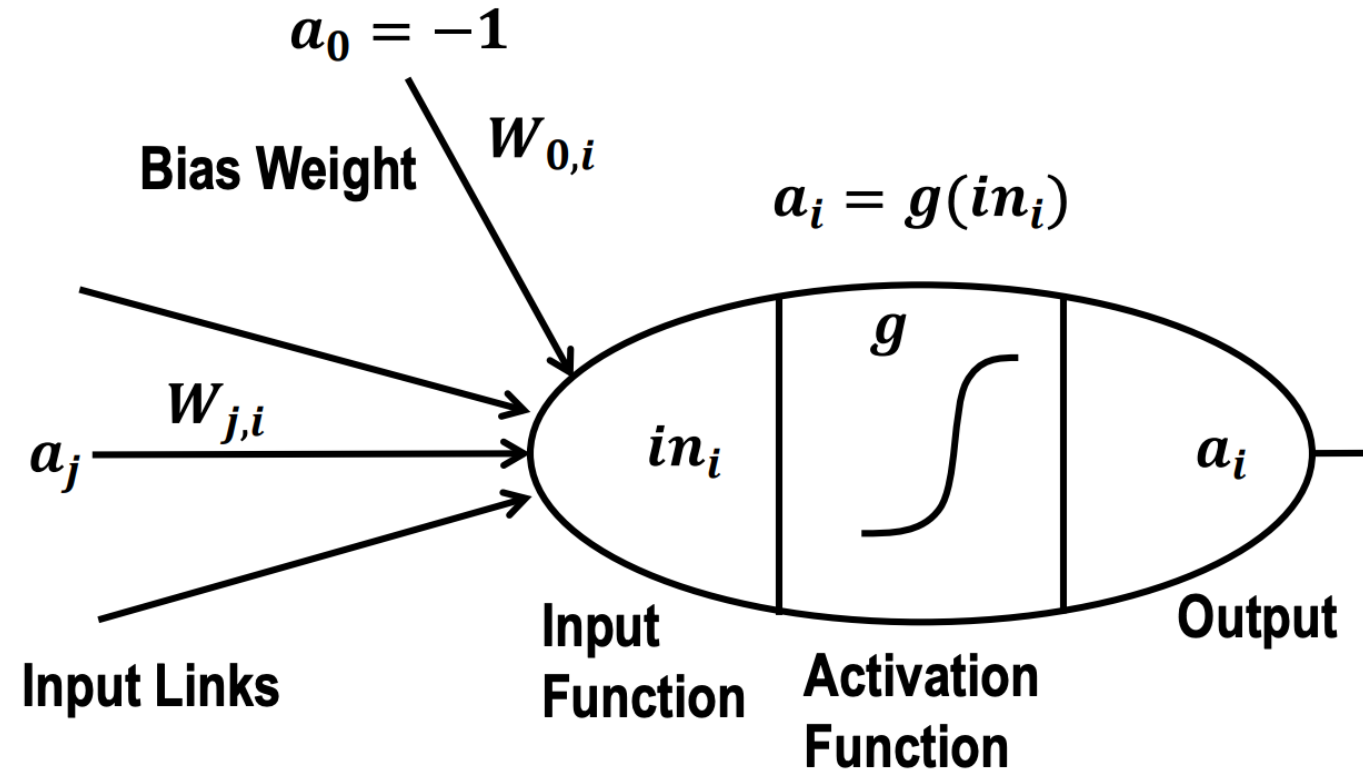
# Neural Networks

A neural network consists of a set of nodes (neurons/units) connected by links

- Each link has a numeric weight

Each unit has:

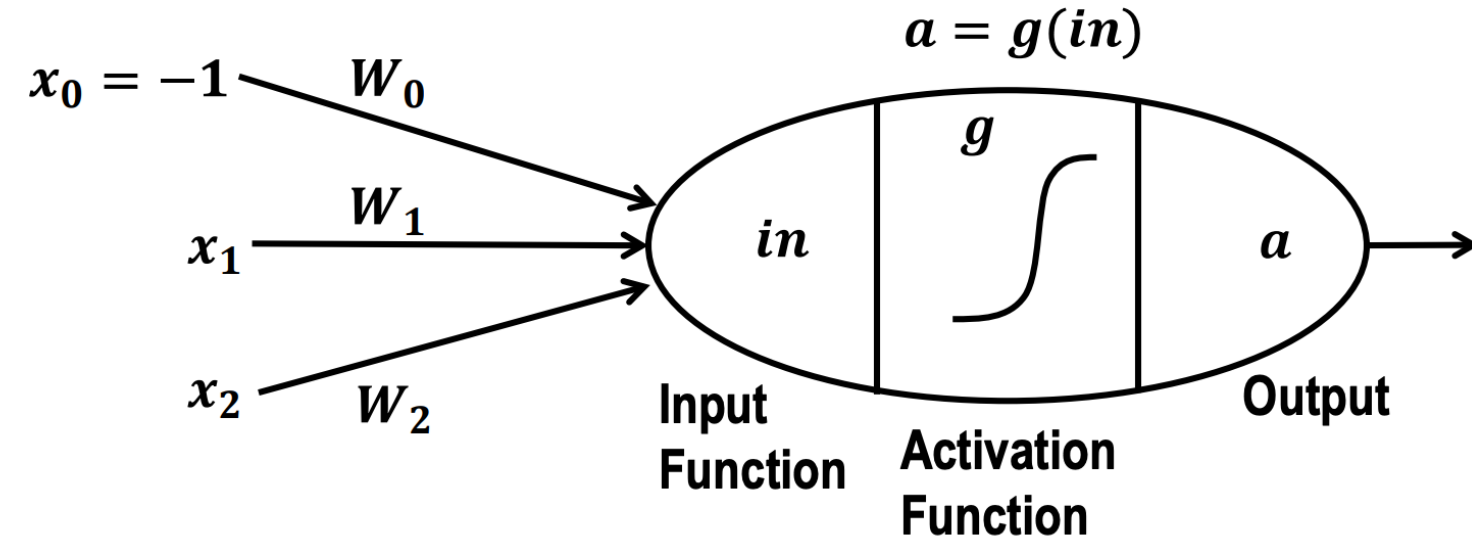
- a set of input links from other units,
- a set of output links to other units,
- a current activation level, and
- an activation function to compute the activation level in the next time step.



$$in_i = \sum_{j=0}^n W_{j,i} a_j$$

$$a_i = g(in_i) = g\left(\sum_{j=0}^n W_{j,i} a_j\right)$$

# Perceptron

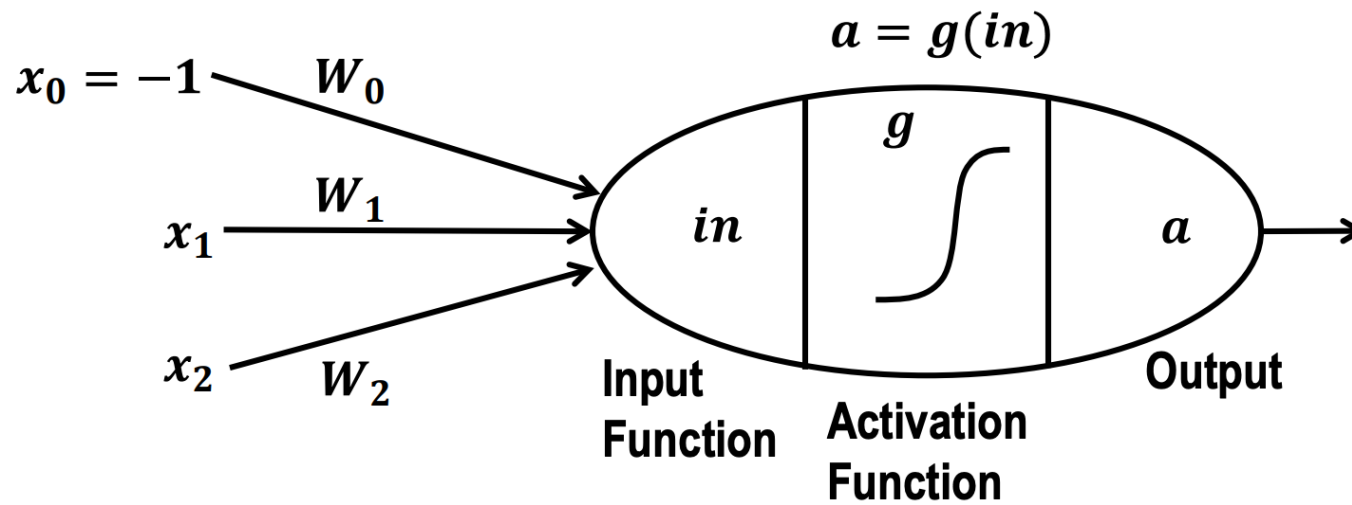


$$in = \sum_{j=0}^2 W_j x_j$$

$$a = \begin{cases} 0 & \text{if } in \leq 0 \\ 1 & \text{if } in > 0 \end{cases}$$

Studying a perceptron helps us to understand the limitations in capacity and the corresponding inability to model certain types of functions.

# Perceptron



**Linear Function:**

$$in = x_1W_1 + x_2W_2 - W_0$$

$$a = \begin{cases} 0 & \text{if } in \leq 0 \\ 1 & \text{if } in > 0 \end{cases}$$

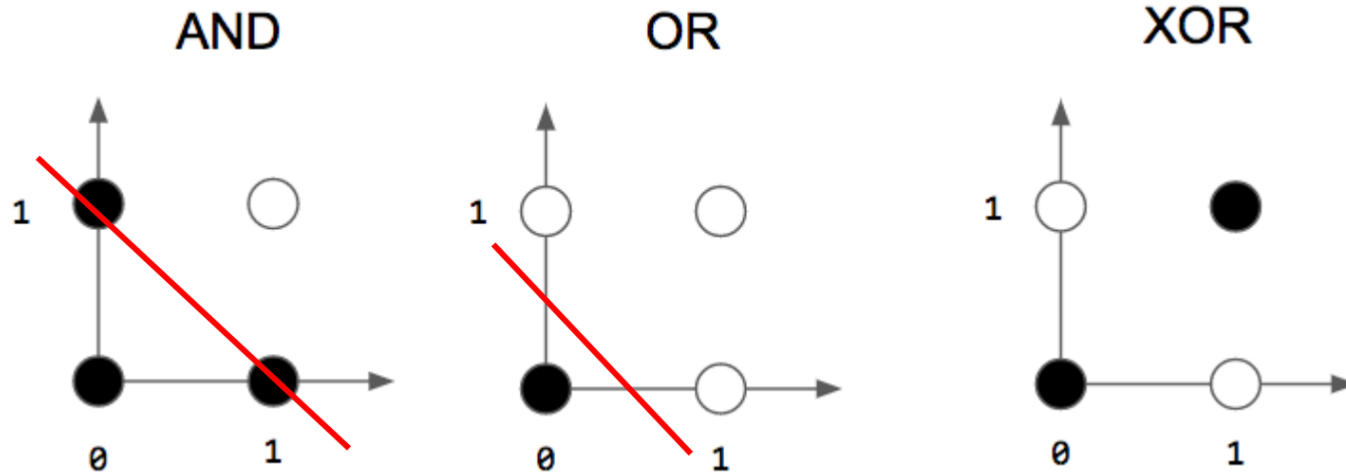
**AND:**  $W_1 = 1, W_2 = 1, W_0 = 1$

$$in = x_1 + x_2 - 1$$

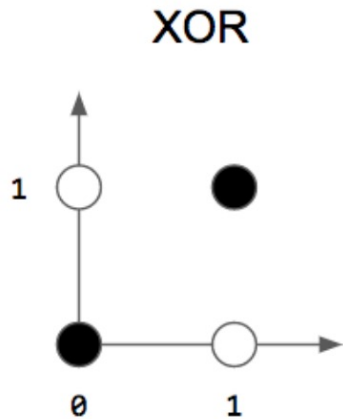
**OR:**  $W_1 = 2, W_2 = 2, W_0 = 1$

$$in = 2x_1 + 2x_2 - 1$$

**What about XOR?**

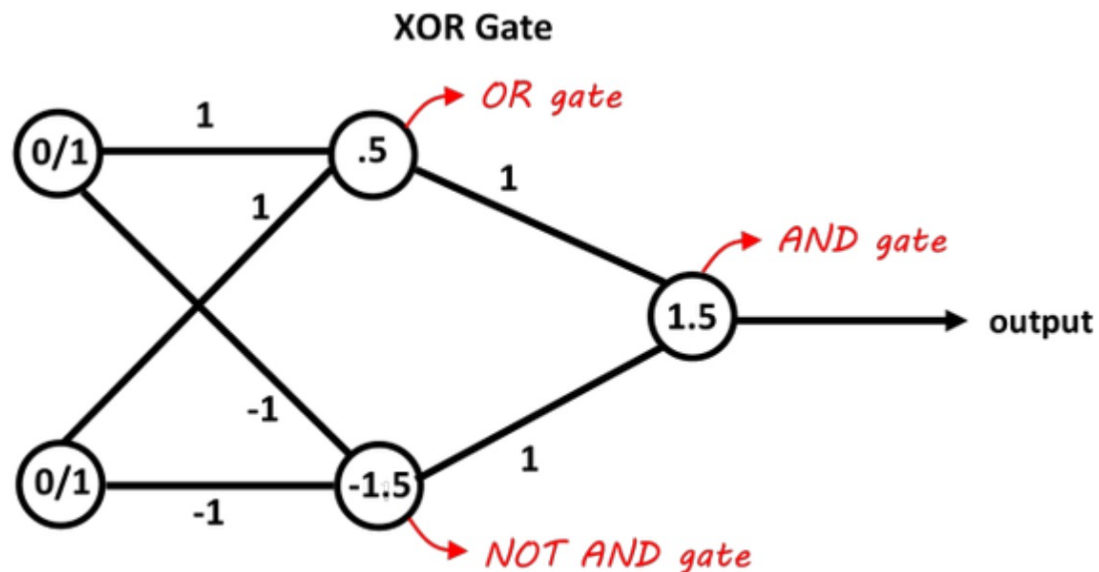


# Multiple Layers Increase the Capacity



The black and white dots are not *linearly separable*, that is, no linear function of the following form separates them:

$$in = x_1W_1 + x_2W_2 - W_0$$



With two layers, it is possible to model the XOR function.