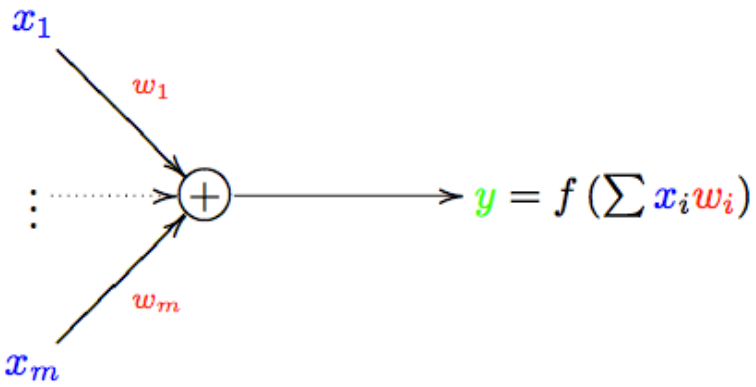
ARTIFICIAL NEURAL NETS

Model of a neutron:



x_1, x_2, … x_m are the input values having weights w_1, w_2, … w_m respectively. These represent the input attributes. The neuron performs computation as follows:

$$v = w_1 x_1 + w_2 x_2 + \cdots + w_m x_m = \sum_{i=1}^{m} w_i x_i$$

f is called the activation function.

Various types of activation functions:

- Linear:

$$f(v) = a + v = a + \sum w_i x_i$$

where parameter a is called **bias.**

a is bias, and w's are slopes.

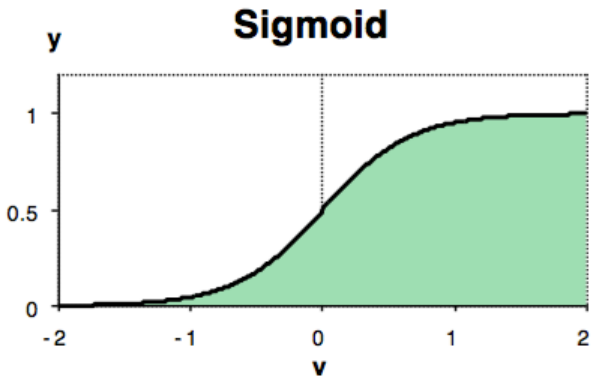
$$f(v) = \begin{cases} 1 & \text{if } v \geq a \\ 0 & \text{otherwise} \end{cases}$$

Here a is called the **threshold**

- Sigmoid function:

$$f(v) = \frac{1}{1 + e^{-v}}$$

where $v = \Sigma\ w_i x_i$



Neurons can be used to represent data models:

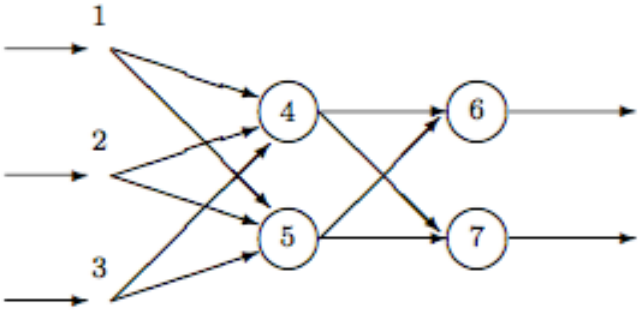
$y = f(x) + \epsilon_i$

Loss or error function can be sum of squares or absolute deviation.

Collections of neurons together make up a **neural network (or neural-nets).**

Cost functions measure error, some examples are mean-square or absolute deviation.

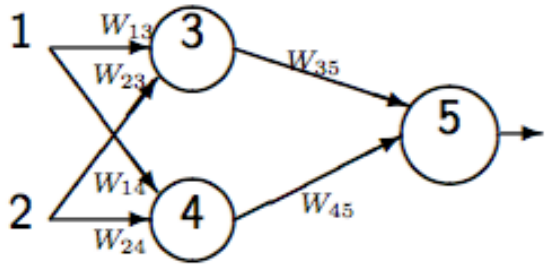
The model can be represented as hidden layer between input and output nodes.



input (nodes 1,2 and 3), hidden (4 and 5) and output (6 and 7) layers.

$w_{ij} \rightarrow$ weight of edge from node i to node j

Example 3.



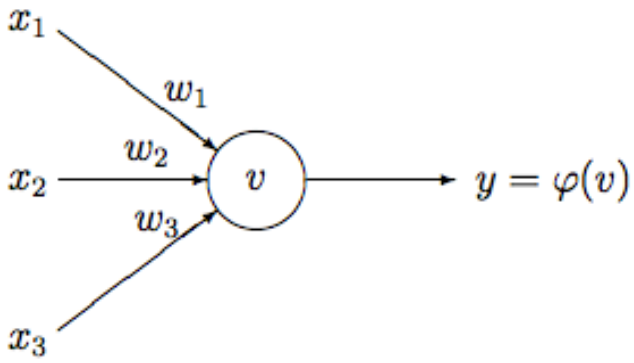
$w_{13} = 2$ $w_{23} = -3$	$w_{35} = 2$
$w_{14} = 1$ $w_{24} = 4$	$w_{45} = -1$

$$f(v) = \begin{cases} 1 & \text{if } v \geq 0 \\ 0 & \text{otherwise} \end{cases}$$

What is the network output, if the inputs are $x_1 = 1$ and $x_2 = 0$?

ANN Training Algorithm can be applied to supervised learning. You are given a set of data with output labels, the algorithm seeks to find the best set of weights.

Below is a diagram for an ANN:



Suppose the weights vector is given by: w = (2, -4, 1).
Perform binary classification using the linear (threshold = 1) and sigmoid (threshold=0.5) activation functions for the following vectors:

$\mathbf{x_1}$ = (1, 0 , 0)

$\mathbf{x_2}$ = (0, 1 , 1)

$\mathbf{x_3}$ = (1, 0 , 1)

$\mathbf{x_4}$ = (1, 1 , 1)

Hint: First calculate $\Sigma w_i x_i$ and then apply activation function, if result more than threshold, assign class = 1 else class 0

Representing Boolean functions using ANN:

Represent the AND and OR functions using ANN and linear activation function ψ. You can use any threshold that makes sense.