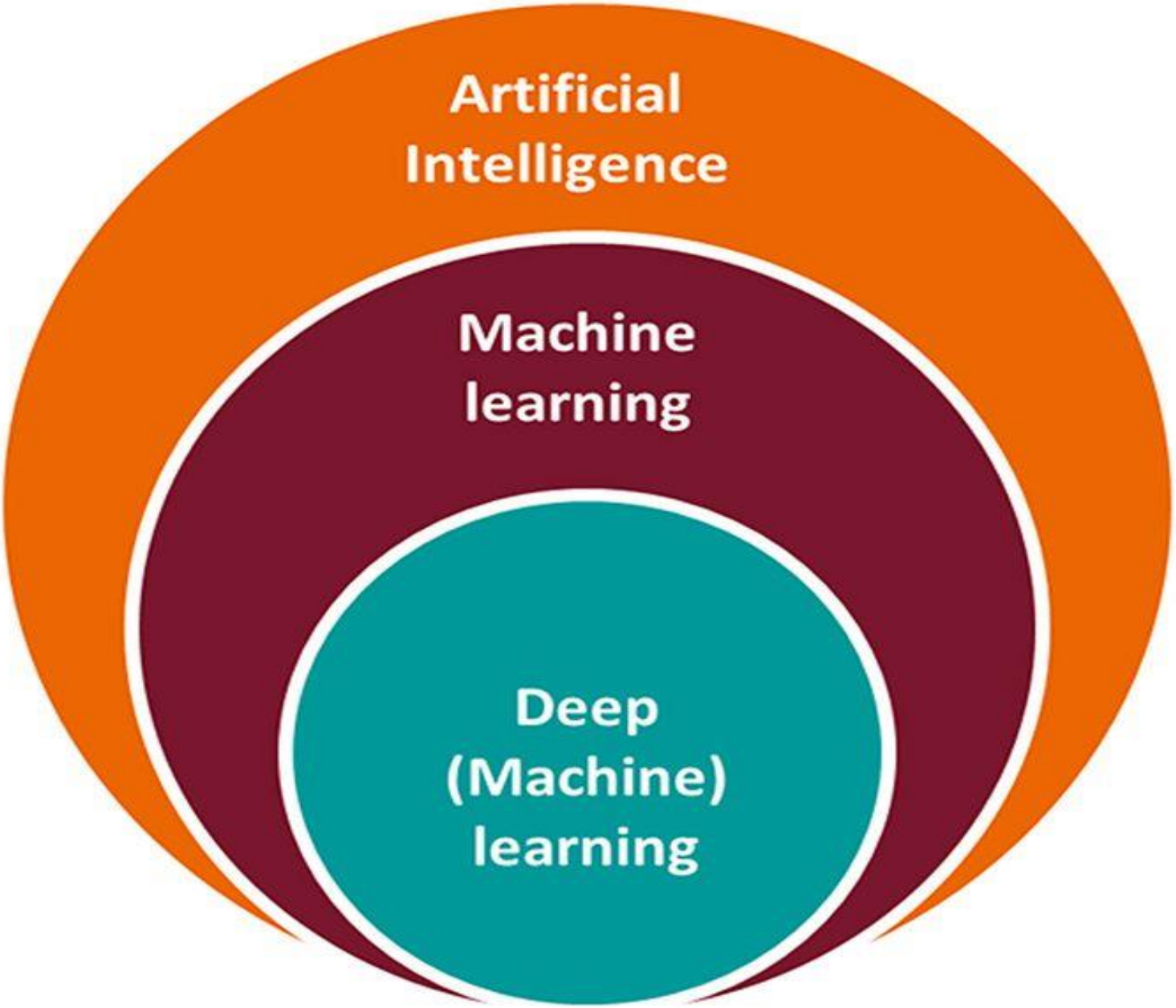
Artificial
Intelligence
Machine
learning
Deep
(Machine)
learning

AI is a very general field which encompasses machine learning and deep learning,

“Machine Learning is a subset of artificial intelligence. It allows the machines to learn and make predictions based on its experience(data)“

Deep Learning — A Technique for Implementing Machine Learning
Deep Learning is a specialized form of Machine Learning that uses supervised, unsupervised, or semi-supervised learning to learn from data representations.

Deep Learning Architecture

- **RNNs** : Recurrent neural networks
- **LSTM/GRU** : Long short-term memory / Gated recurrent unit
- **DBN** : Deep belief networks
- **CNNs** : Convolutional neural networks
- **DSNs** : Deep stacking networks

Application of Deep Learning Architectures

- **RNN** : Its is mostly employed in speech & hand-writing recognition
- **LSTM/GRU** : Natural language text compression, handwriting recognition, speech recognition, gesture recognition, image captioning
- **CNN** : Image recognition, video analysis, natural language processing
- **DBN** : Image recognition, information retrieval, natural language understanding, failure prediction
- **DSN** : Information retrieval, continuous speech recognition

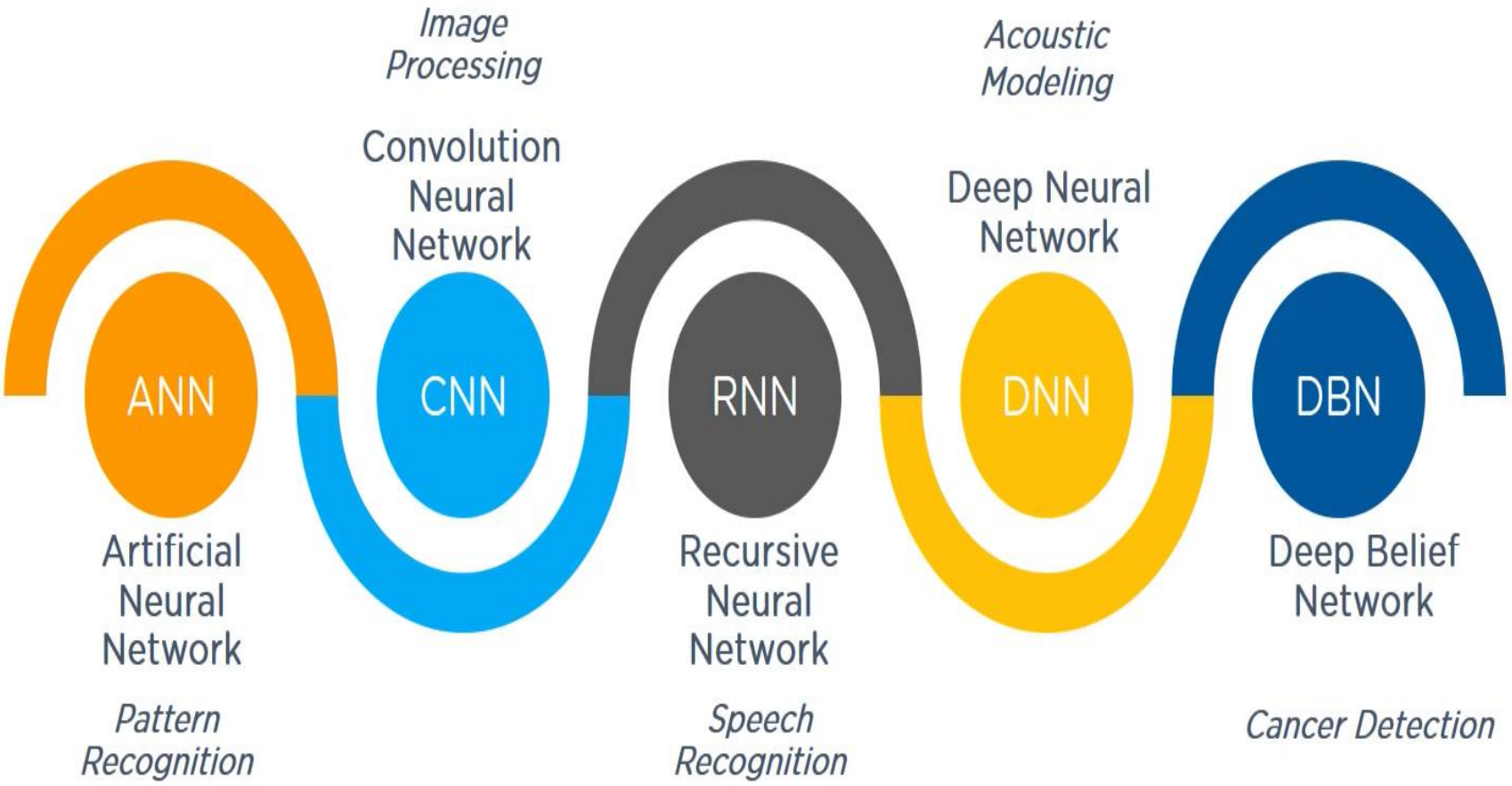
Image Processing
Convolution Neural Network
Acoustic Modeling
Deep Neural Network
ANN
CNN
RNN
DNN
DBN
Artificial Neural Network
Recursive Neural Network
Deep Belief Network
Pattern Recognition
Speech Recognition
Cancer Detection

NEURAL NETWORK

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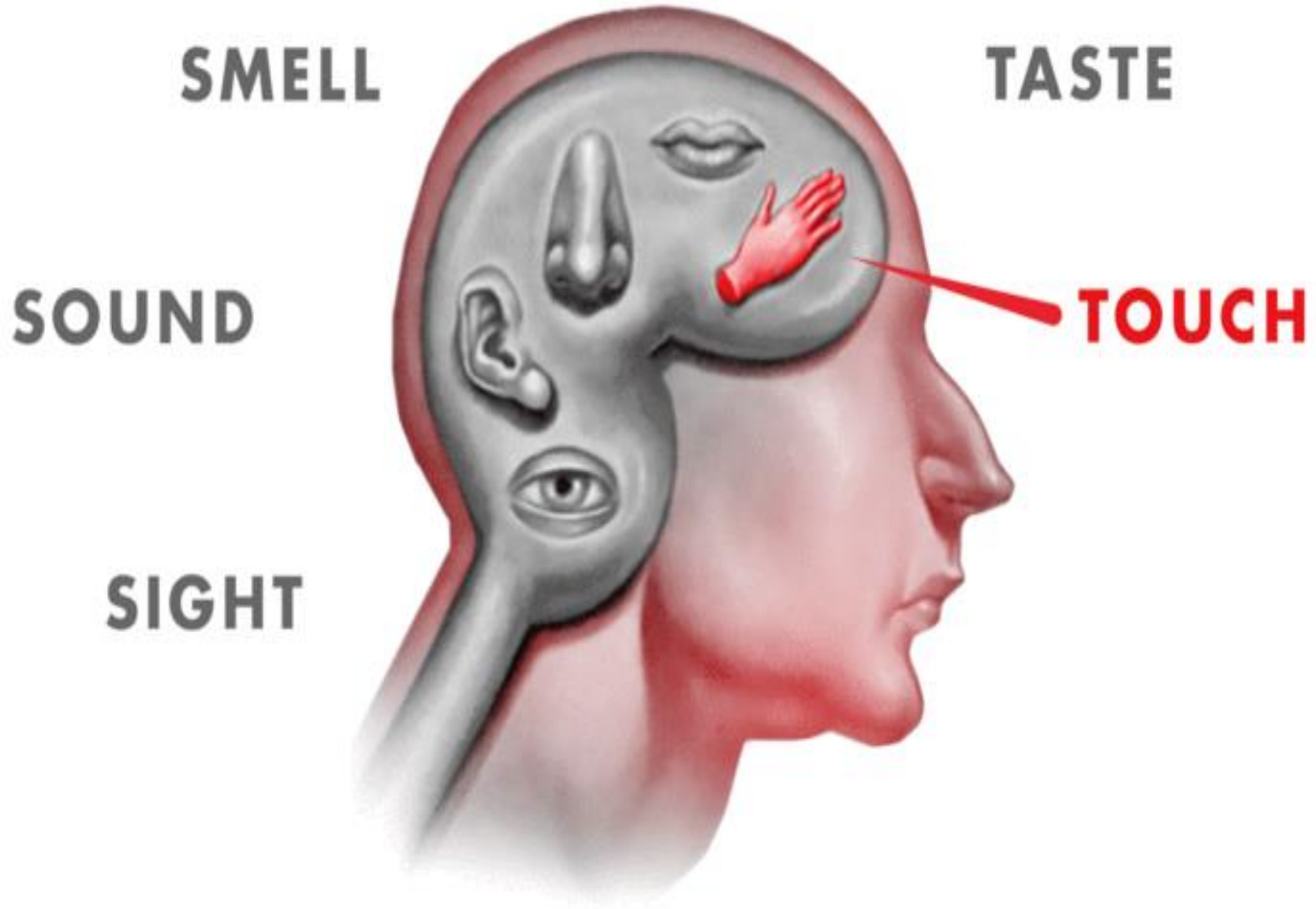
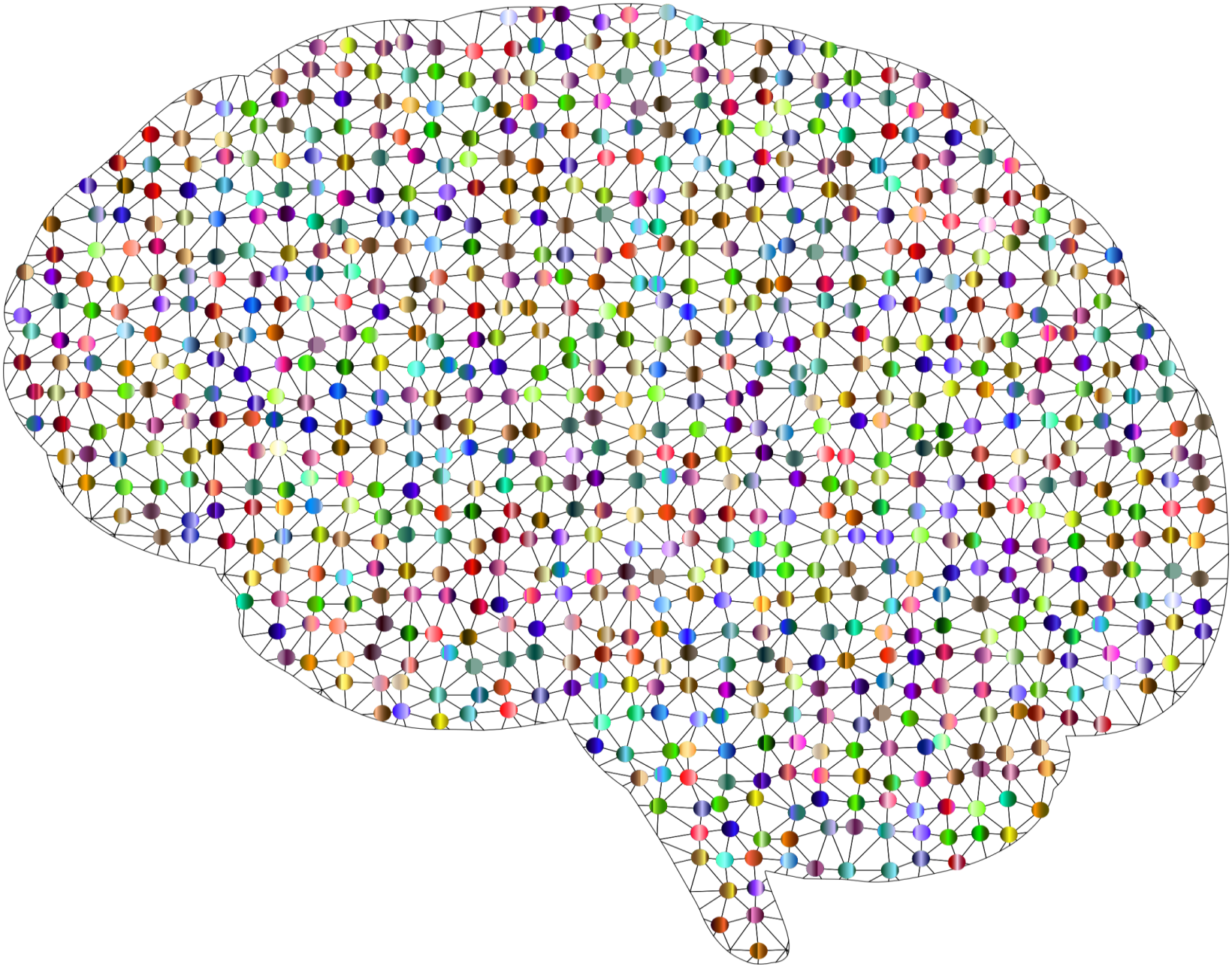

SMELL
TASTE
SOUND
TOUCH
SIGHT

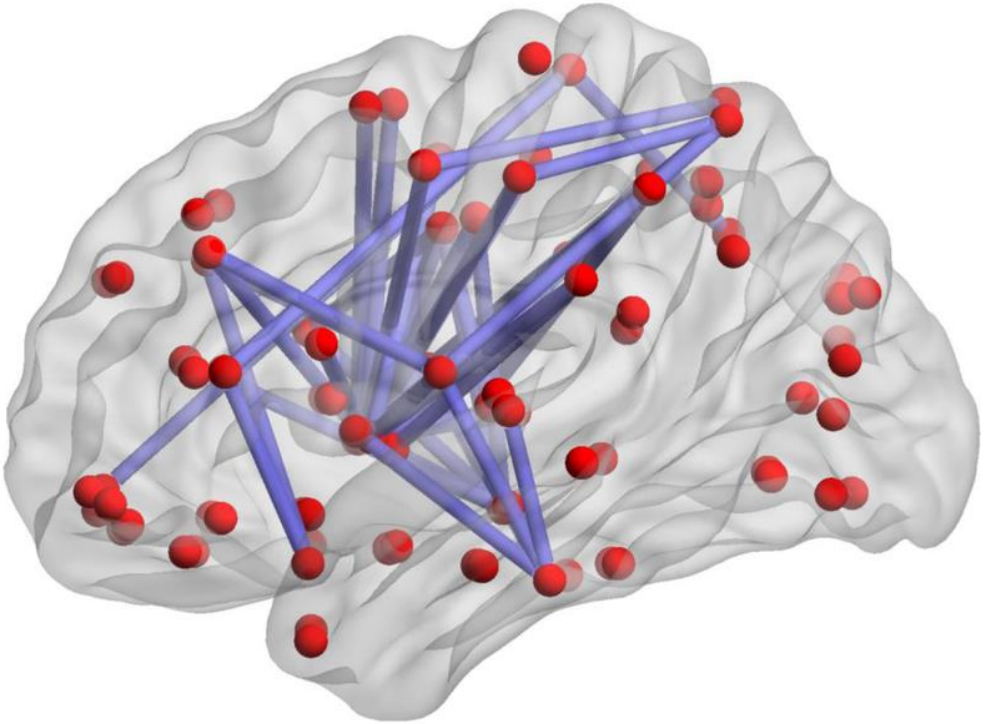


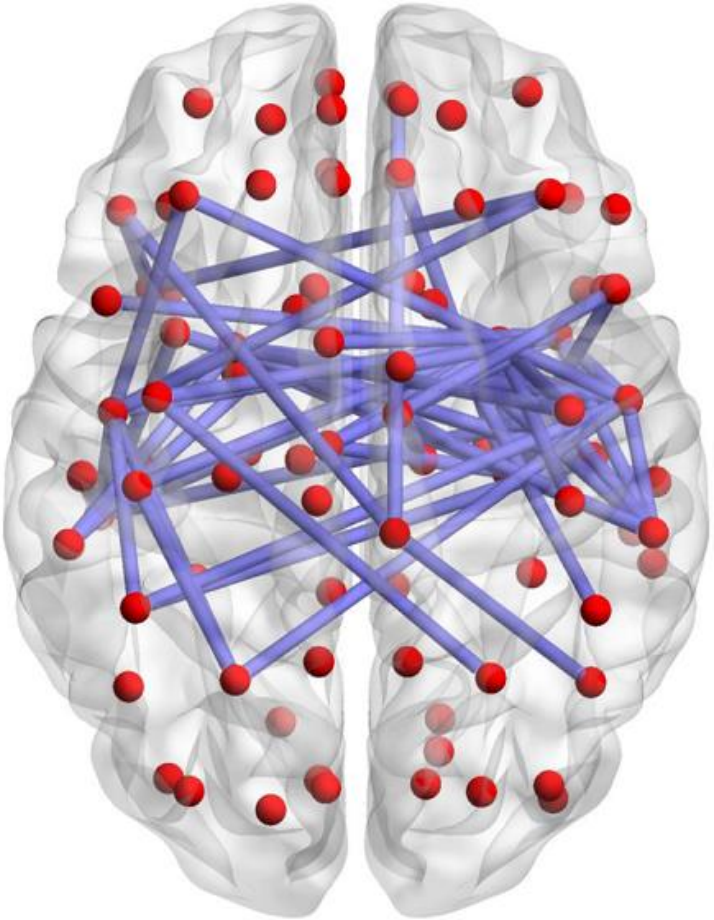
BRAIN

A typical brain contains something like ***100** billion miniscule cells called **neurons.**

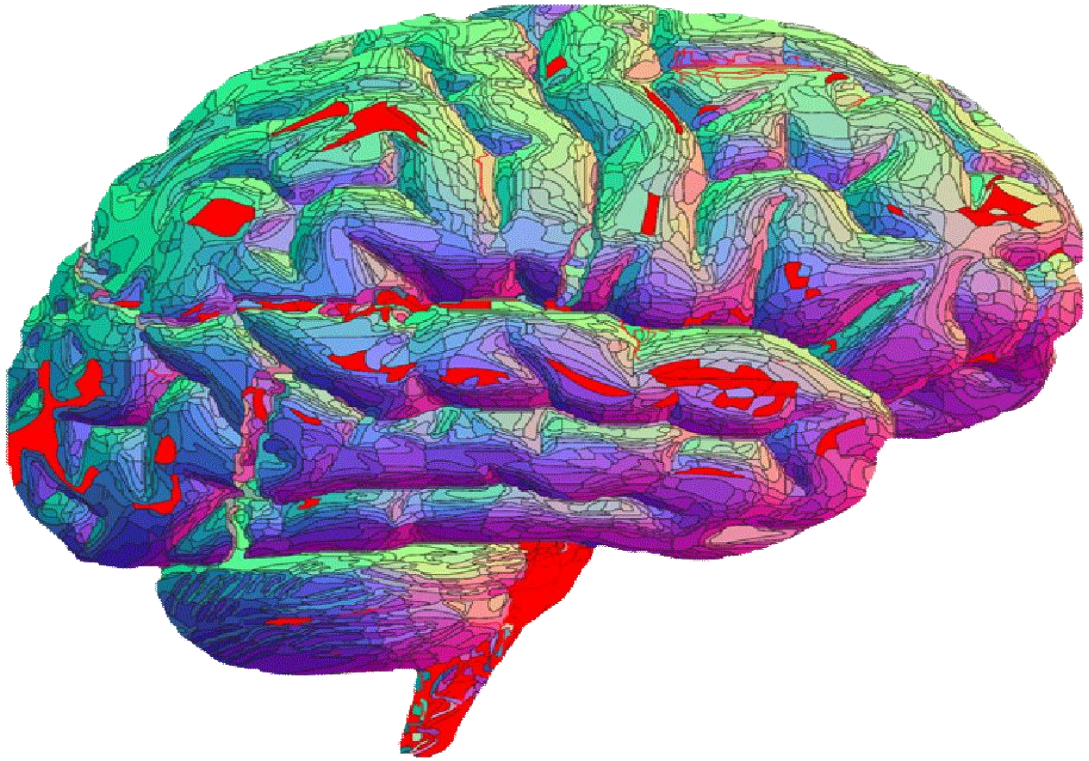
Each neuron is made up of a **cell body** (the central mass of the cell) with a number of connections coming off it.

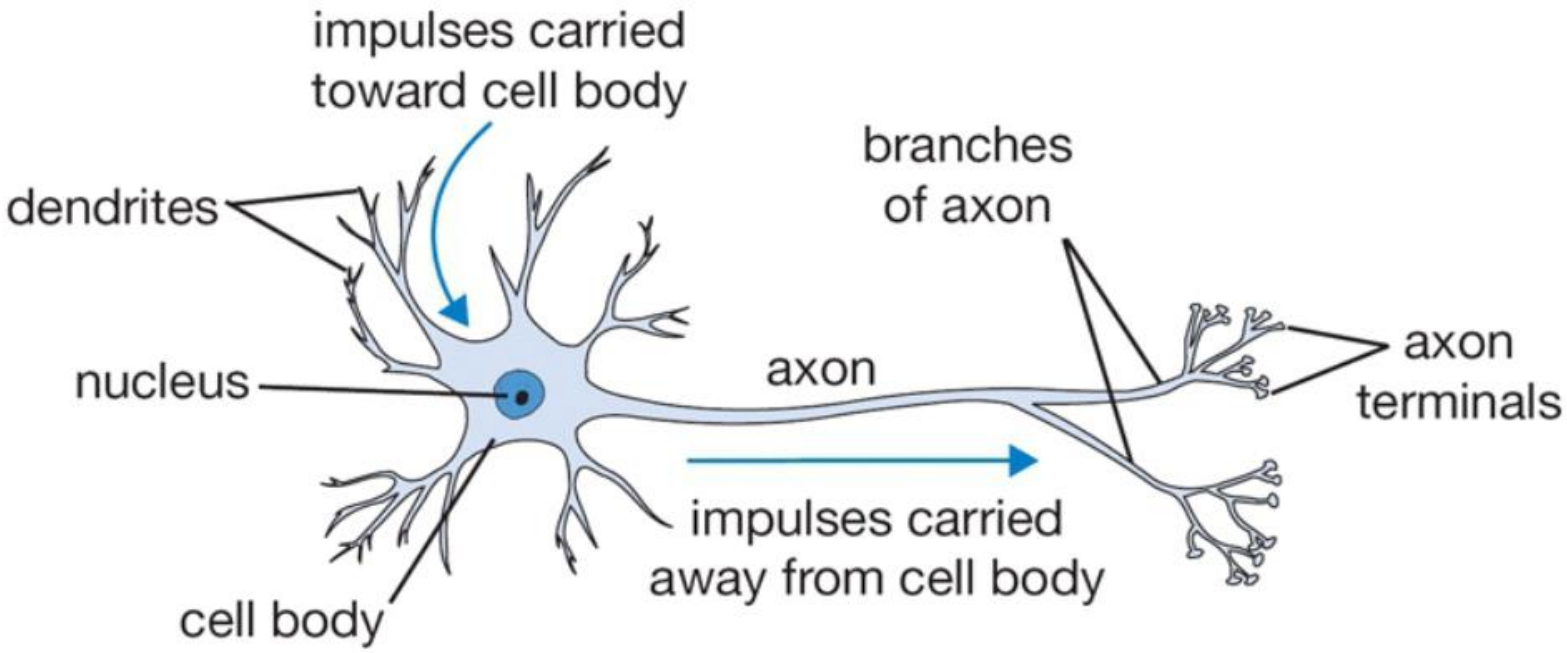
The cell body contains the nucleus, the **storehouse of genetic** information, and gives rise to two types of cell processes, axons and dendrites.





Brain Structure is Parallel and Distributed



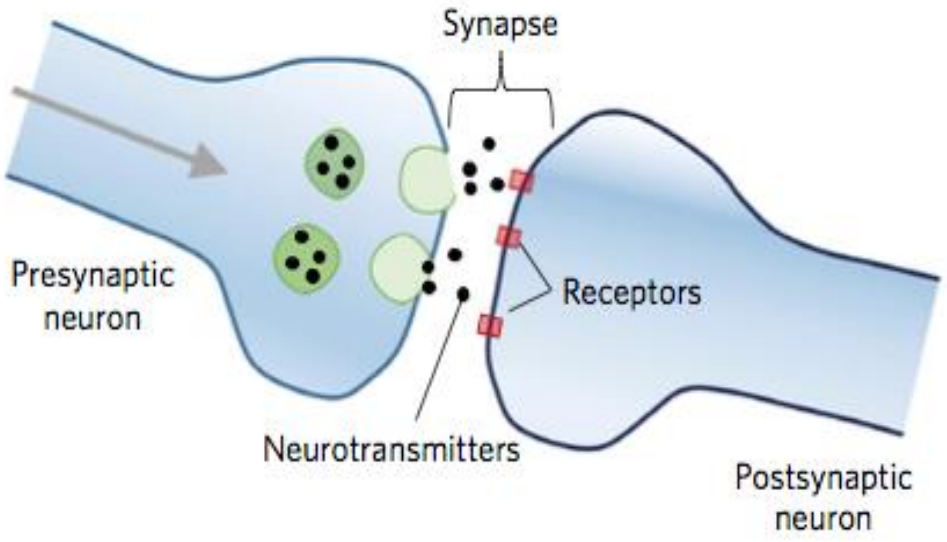


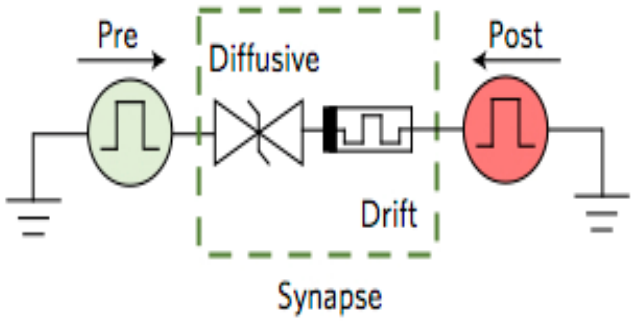
Biological neuron

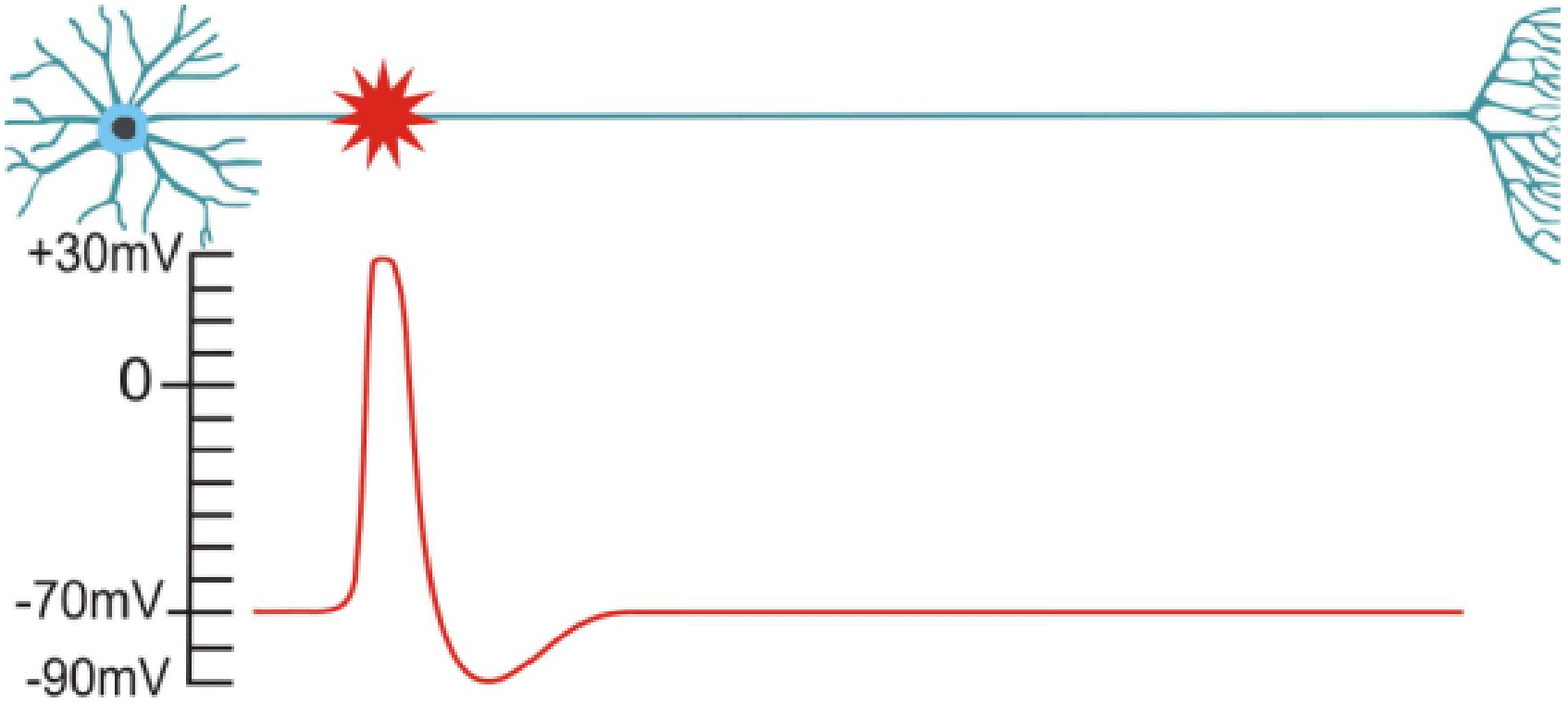
numerous **dendrites** (the cell's inputs—carrying information toward the cell body) and a single **axon** (the cell's output—carrying information away).

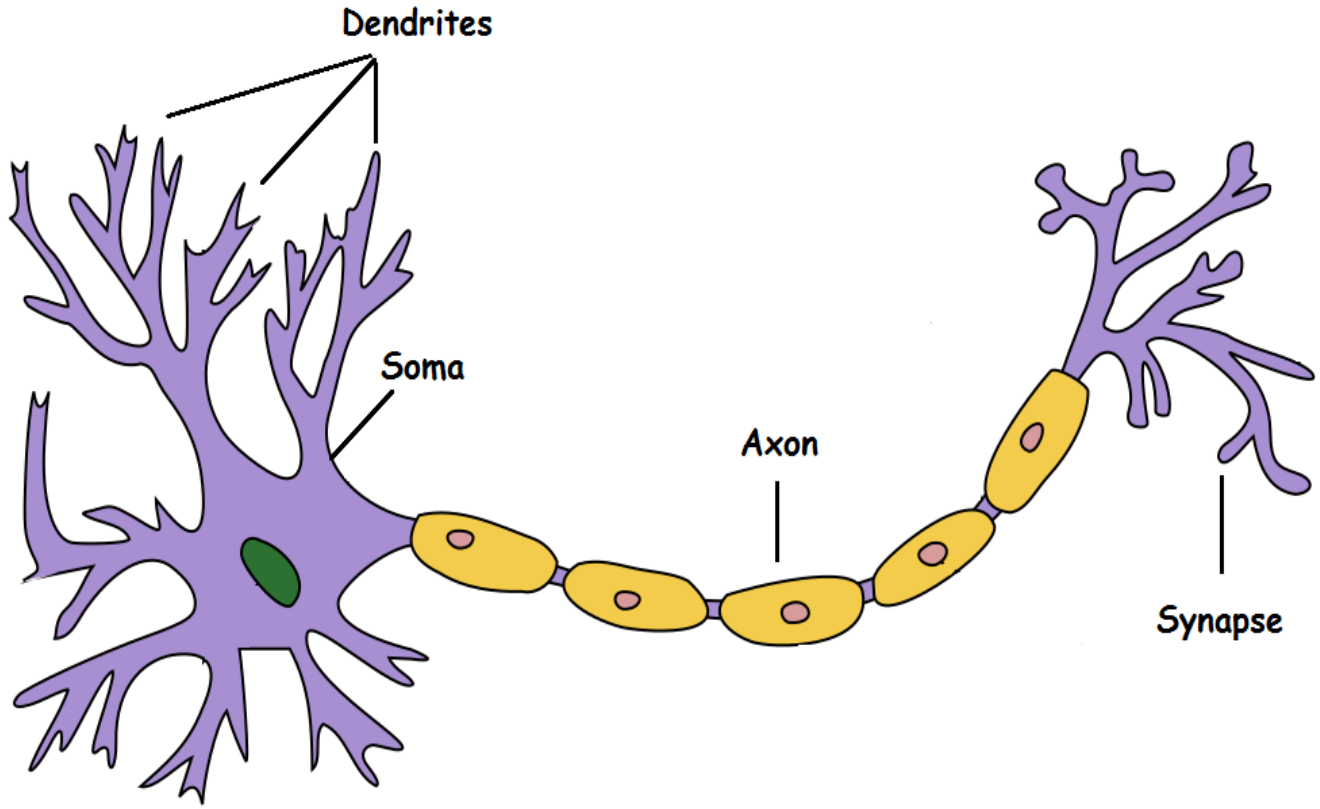
Synapses

The connections between one neuron and another are called synapses. Information always leaves a neuron via its axon , and is then transmitted across a synapse to the receiving neuron.






+30mV
0
-70mV
-90mV



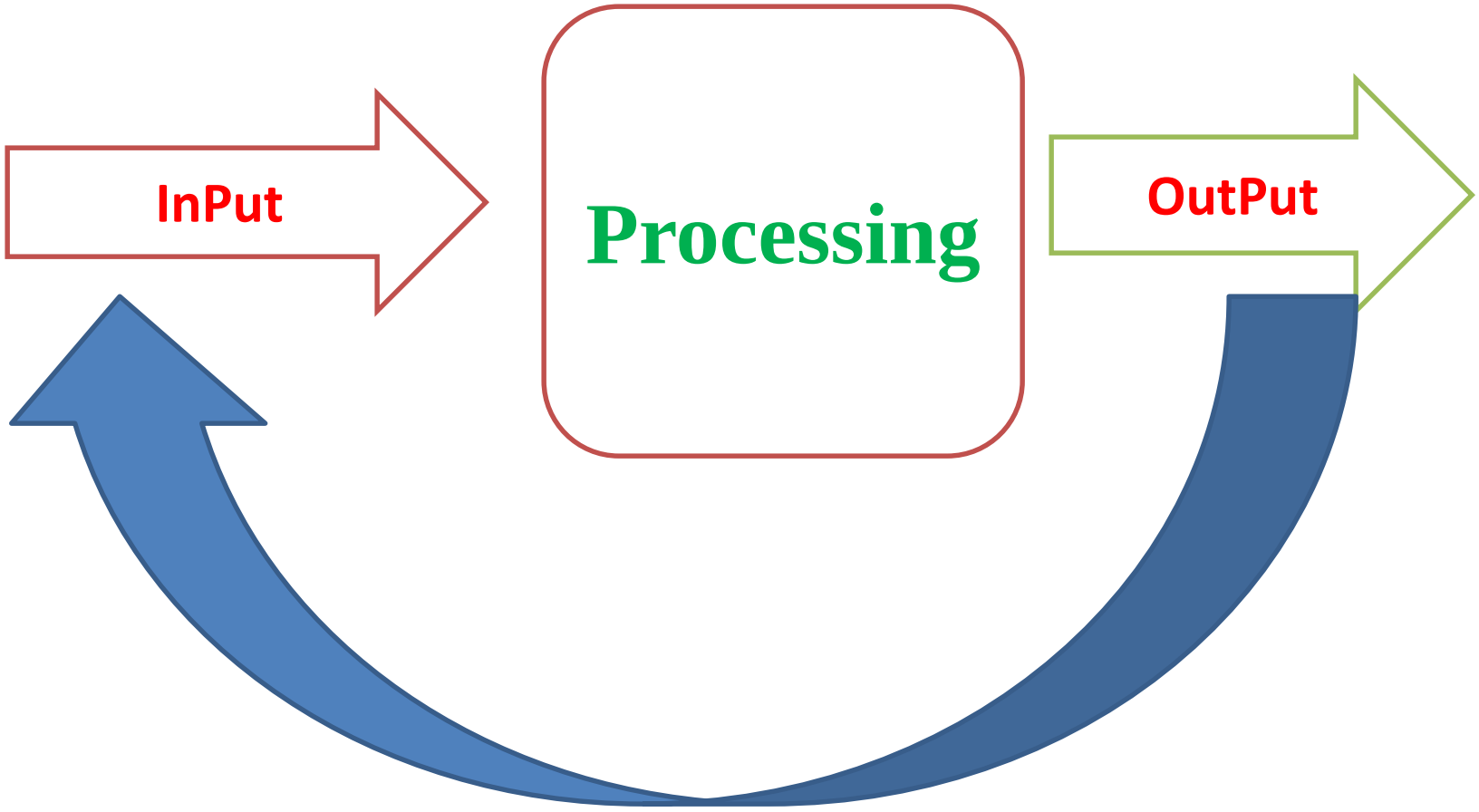
- **Dendrite:** Receives signals from other neurons
- **Soma**: Processes the information
- **Axon**: Transmits the output of this neuron
- **Synapse**: Point of connection to other neurons

The neural system of the human body consists of three stages: **receptors**, **a neural network**, and **effectors**.

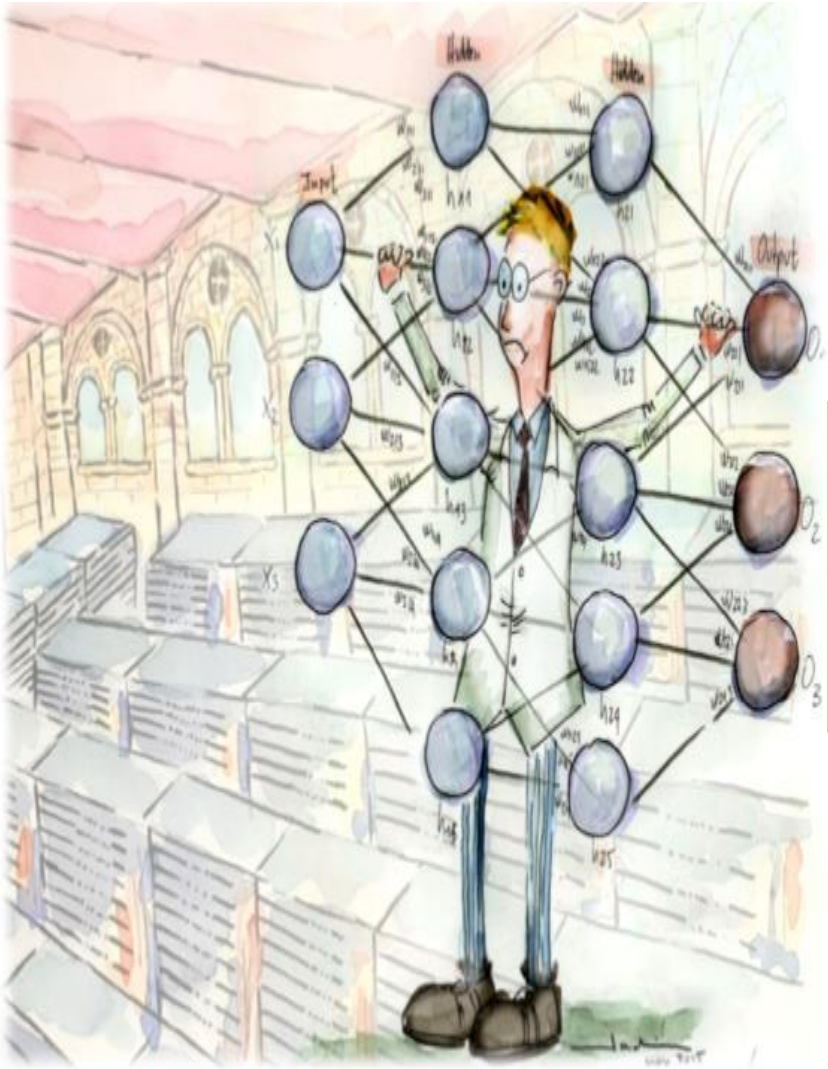
The receptors receive the stimuli either internally or from the external world, then pass the information into the neurons in a form of electrical impulses.

The neural network then processes the inputs then makes proper decision of outputs.

Finally, the effectors translate electrical impulses from the neural network into responses to the outside environment.


InPut
Processing
OutPut

New type of Computing is required

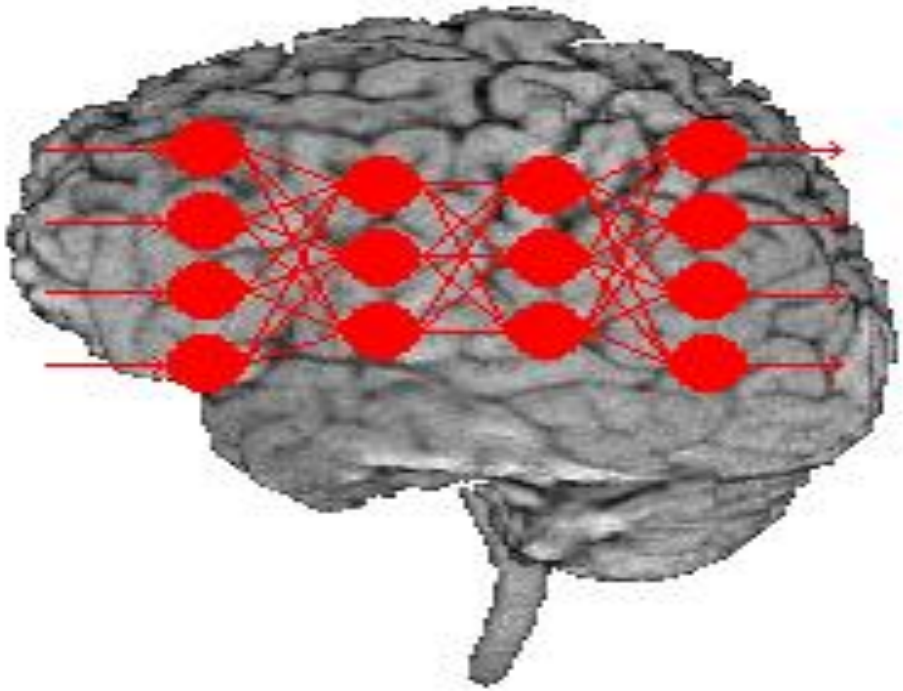


Giving Computers a greater ability to understand information and to learn, to Reason , and act upon it

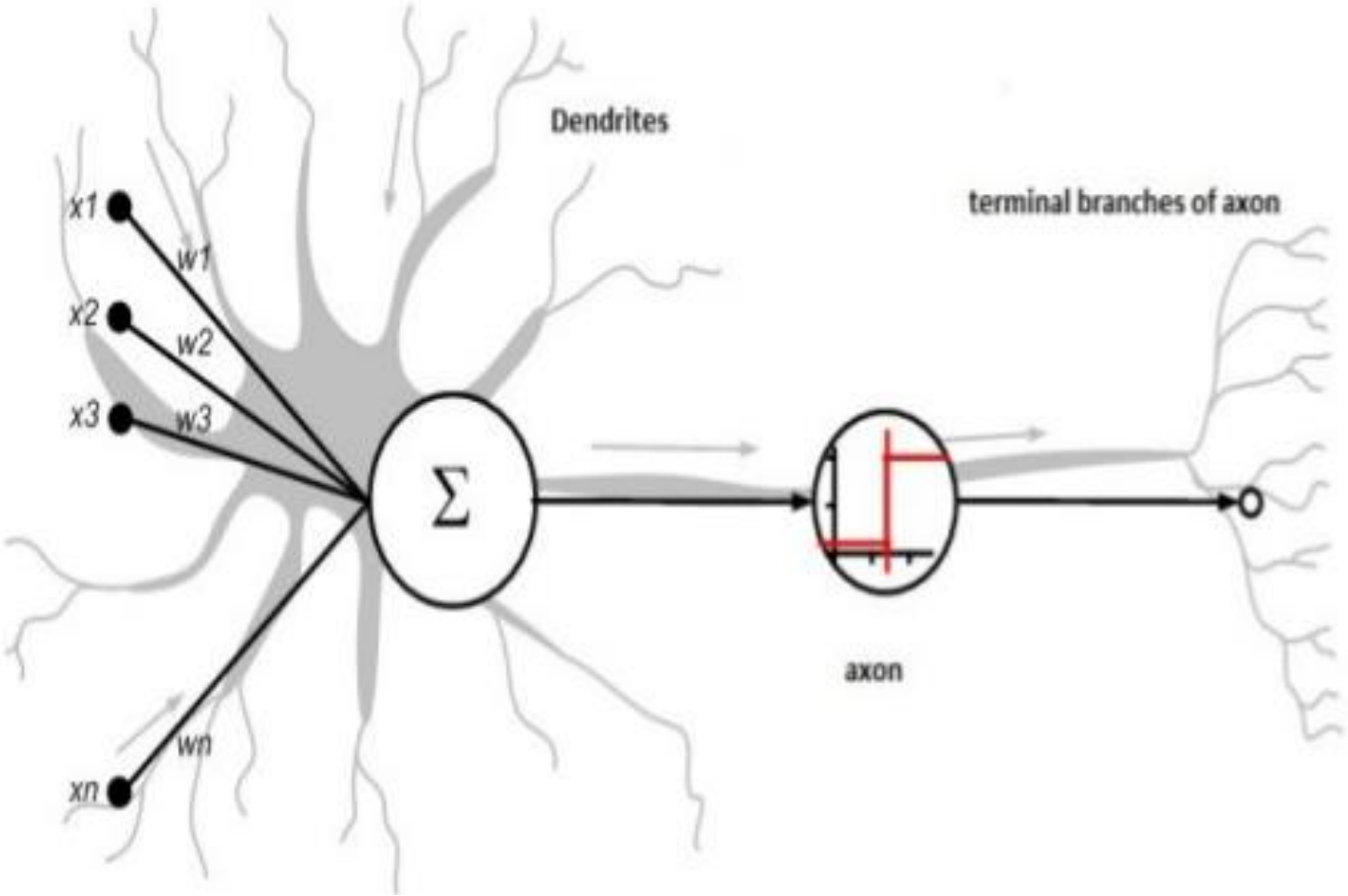
Instead of giving the computer a set of instructions on how to do something, we give it instructions on how to learn to do something.

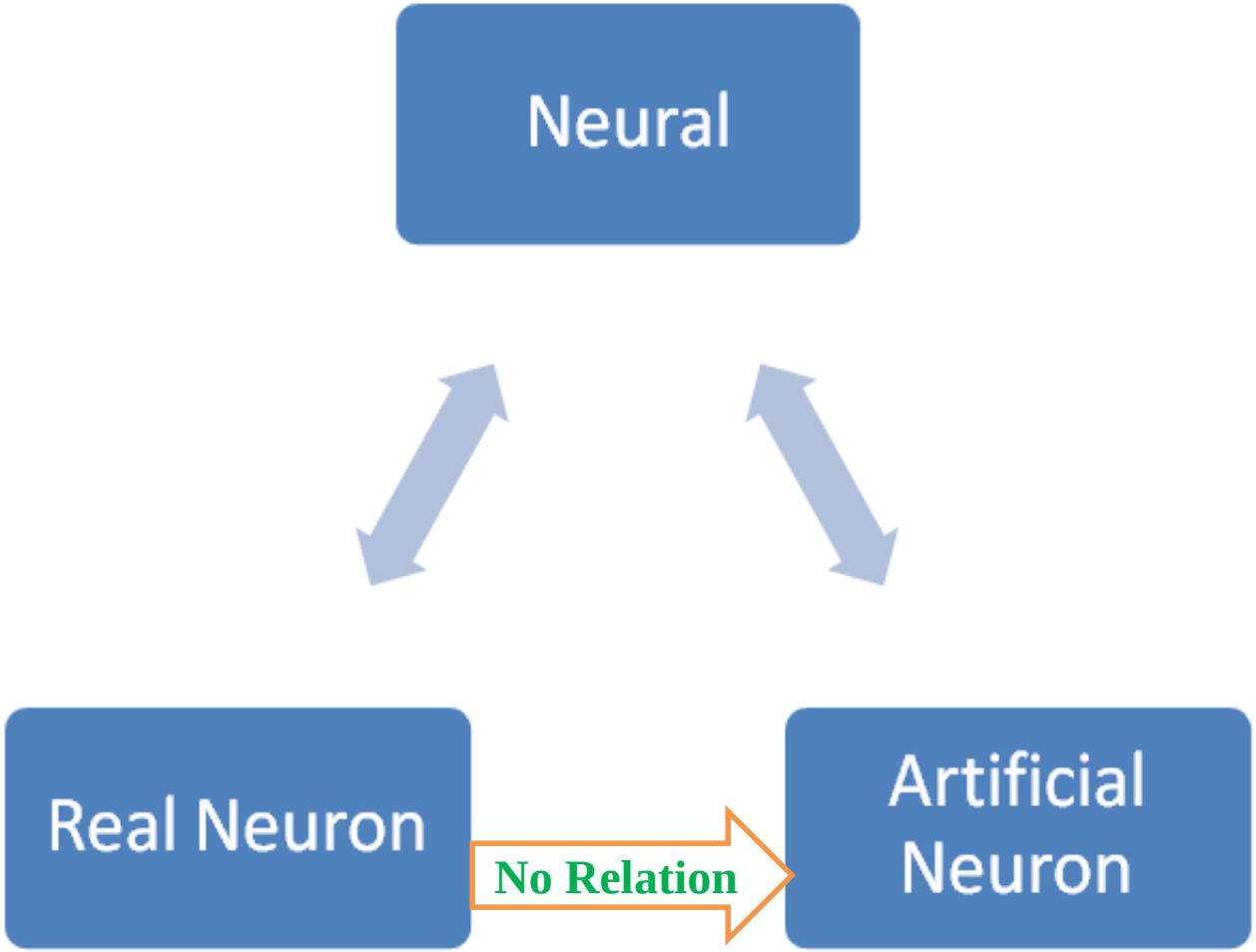
Neural Network

Neural Network is a computer simulation of the biological neuron work within a human brain.



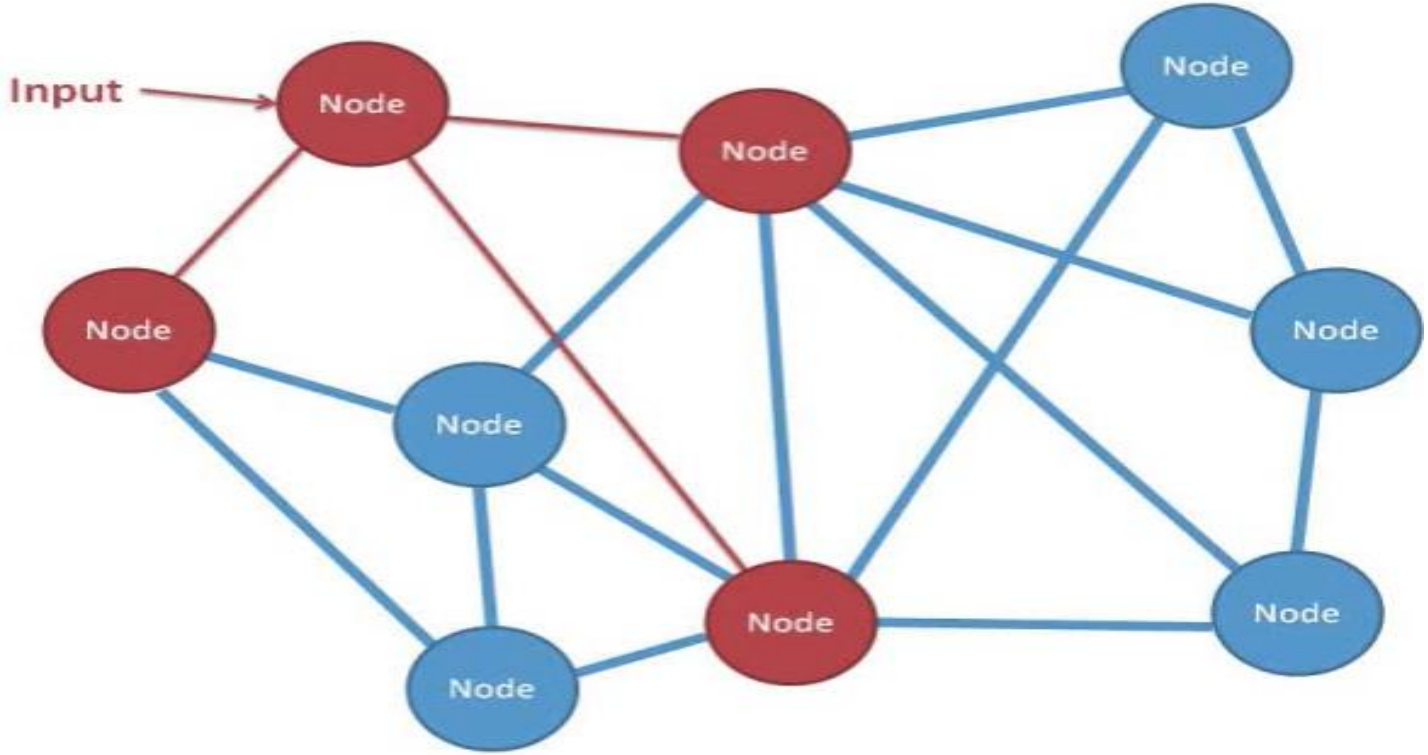
Biologically Inspired Neuron

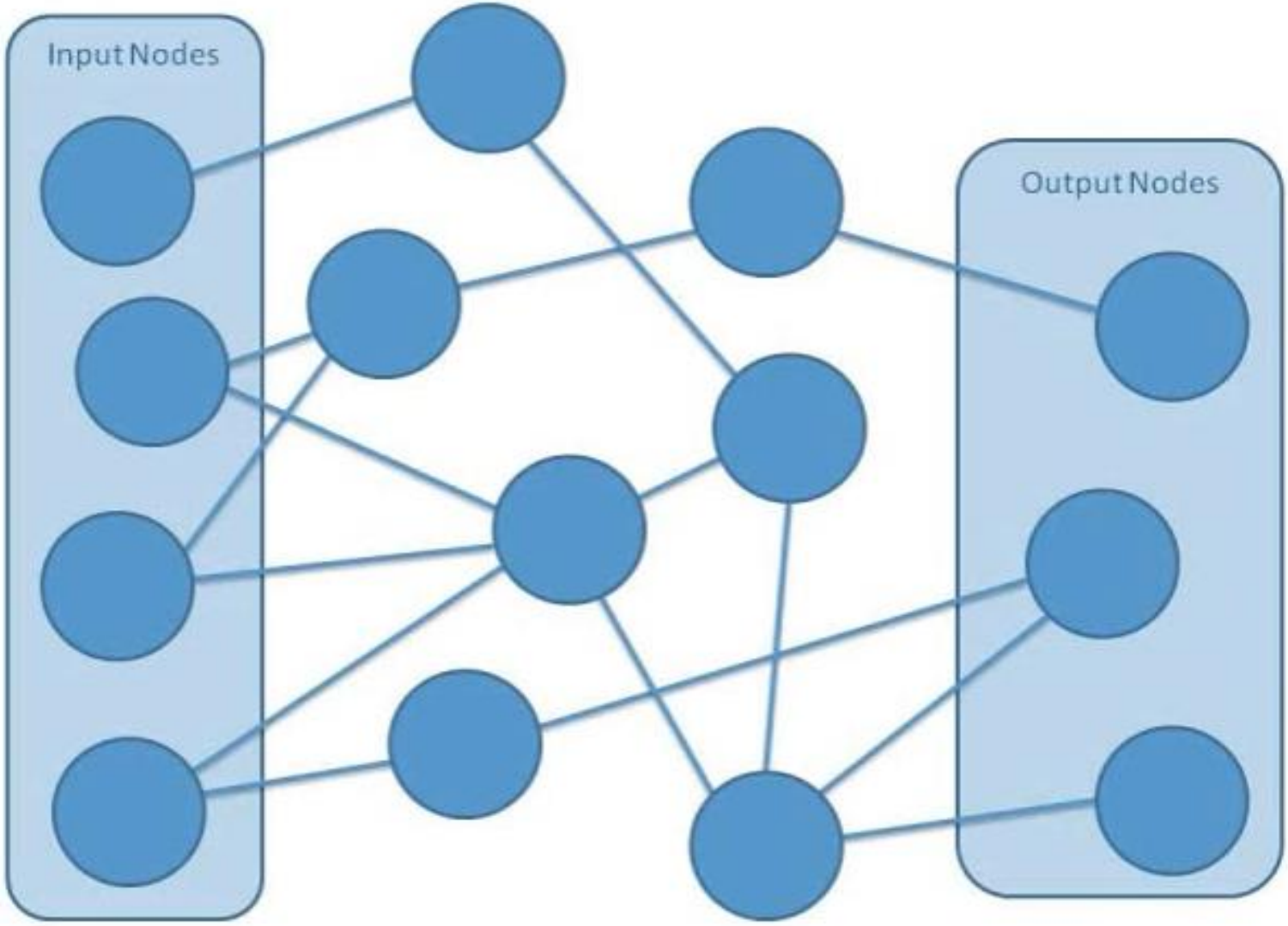




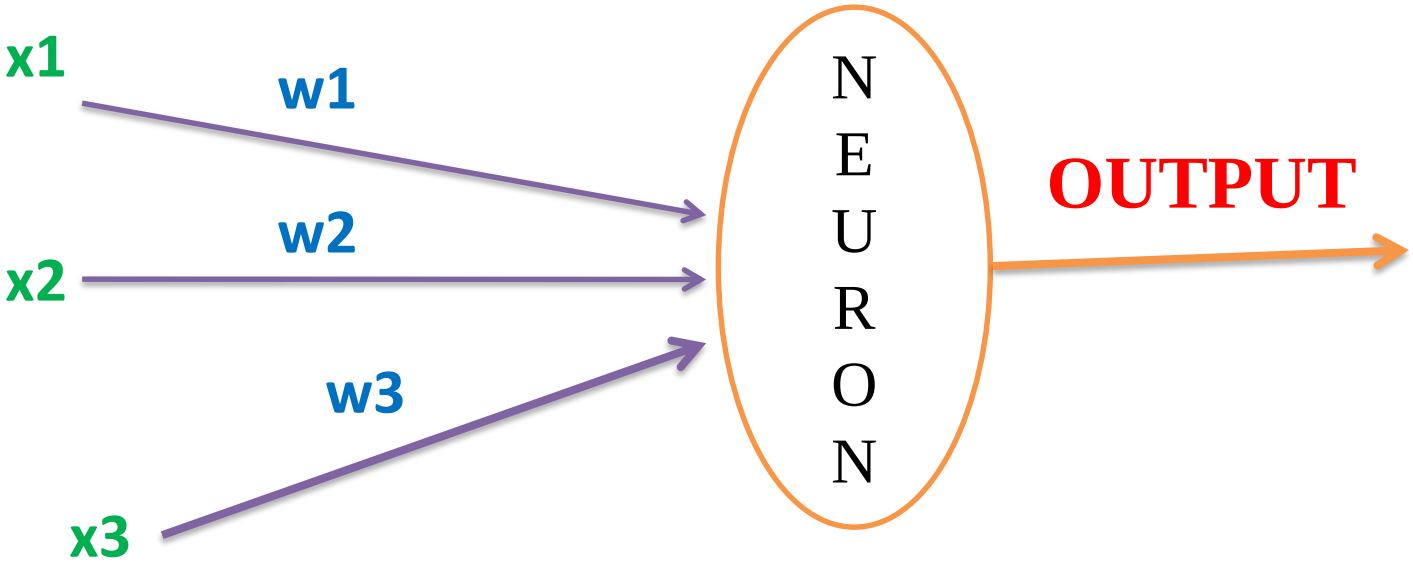
Artificial Neural Network (ANN)

An Artificial Neural Network (ANN) is an interconnected group of nodes, similar to the our brain network.



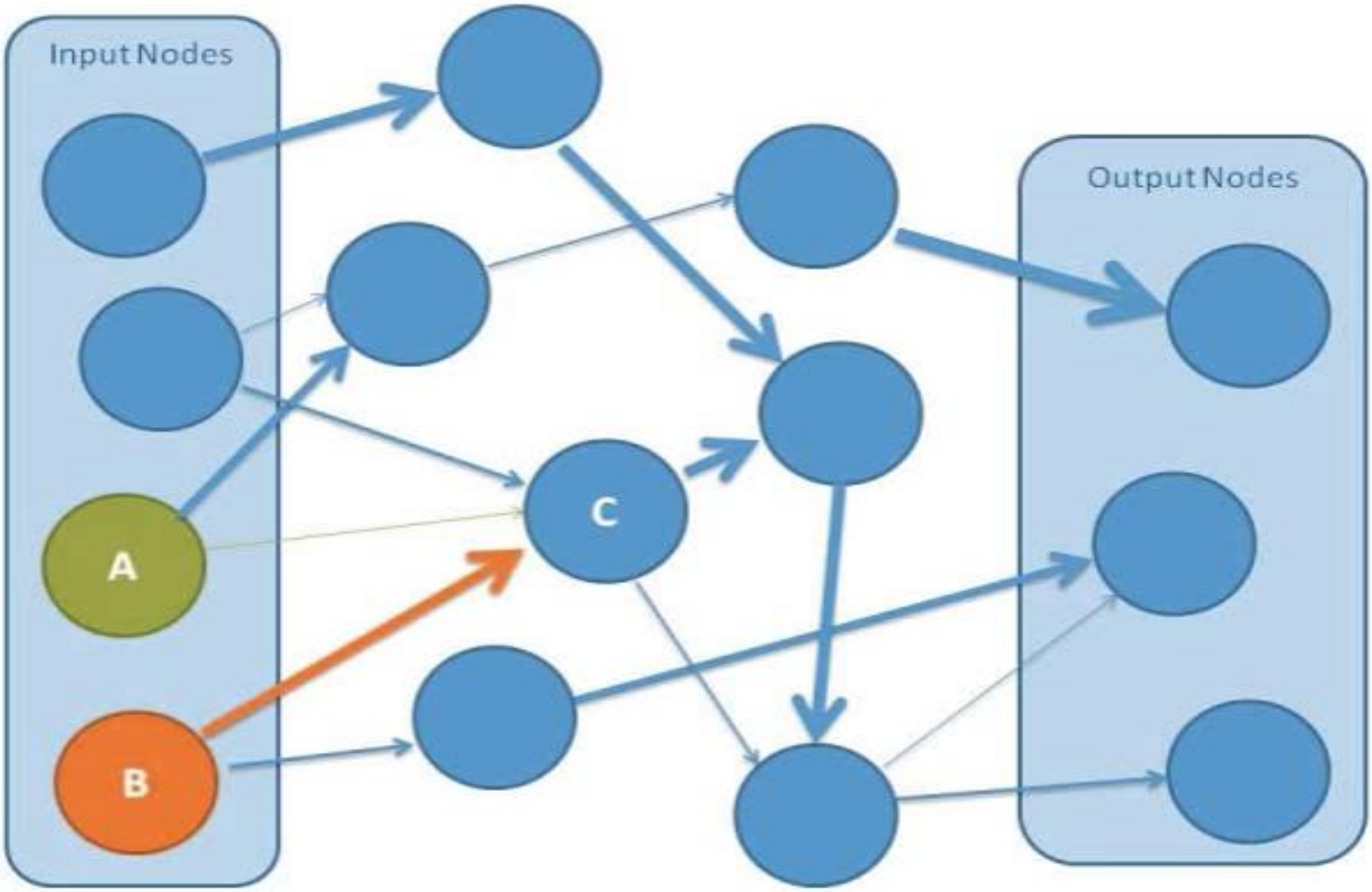


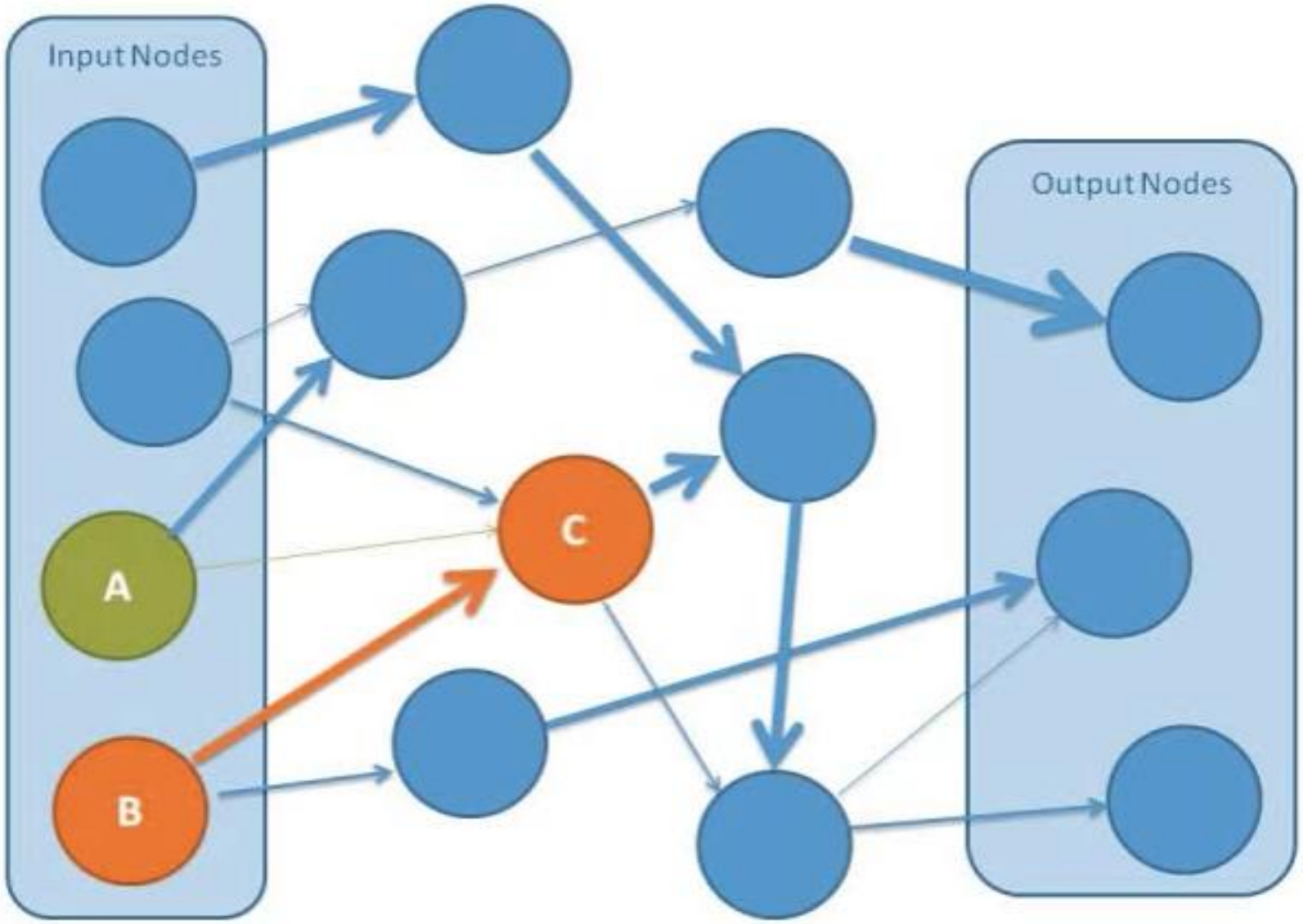
Connection Values Are Called Weights



A neuron is like a function, it takes a few inputs and return an output and their generally goal is to perform a given task achieving the least possible error.

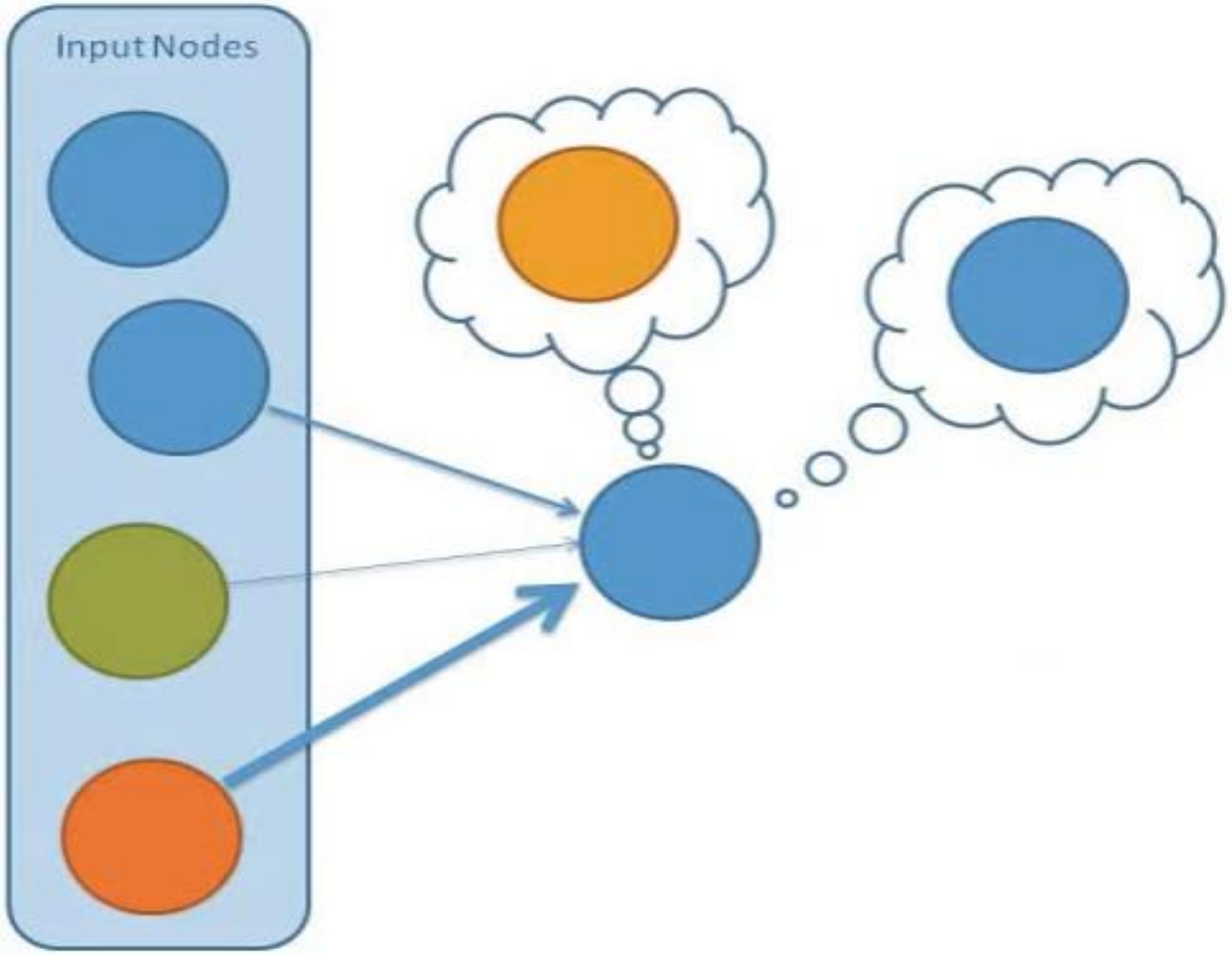
Neuron is a computational unit which takes the input(‘s) , does some calculations and produces the output

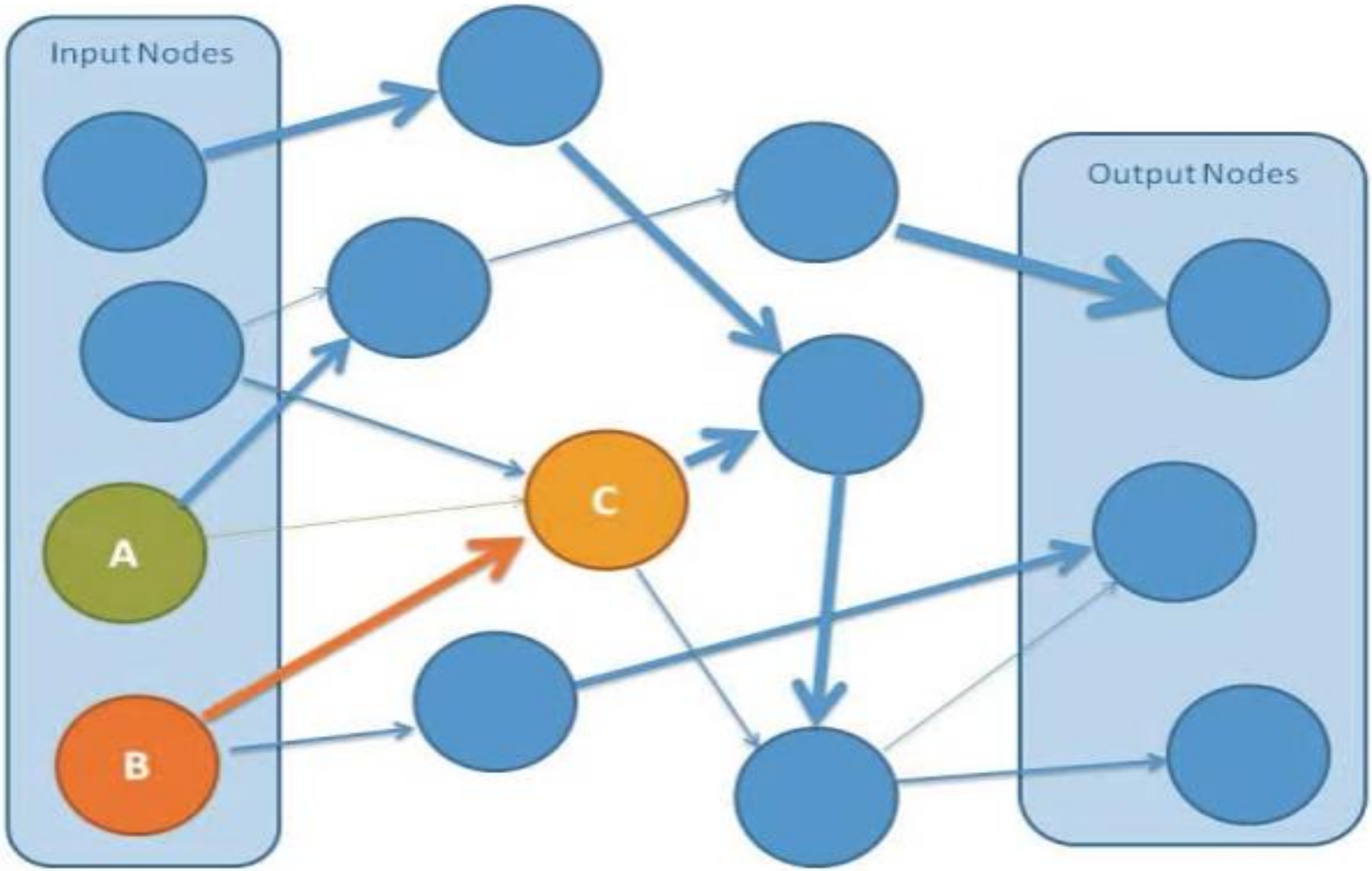




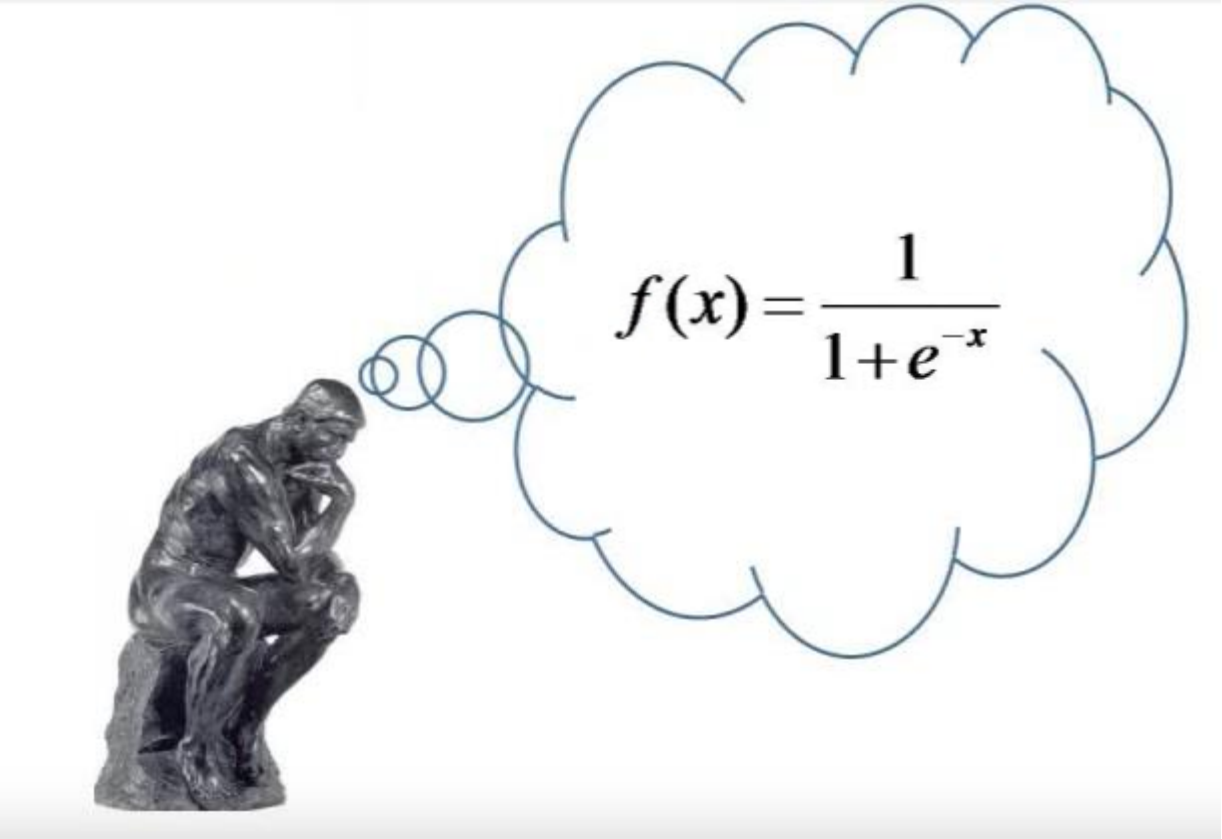
More often Node value design on the basis of

SUM and **Average**





Decision



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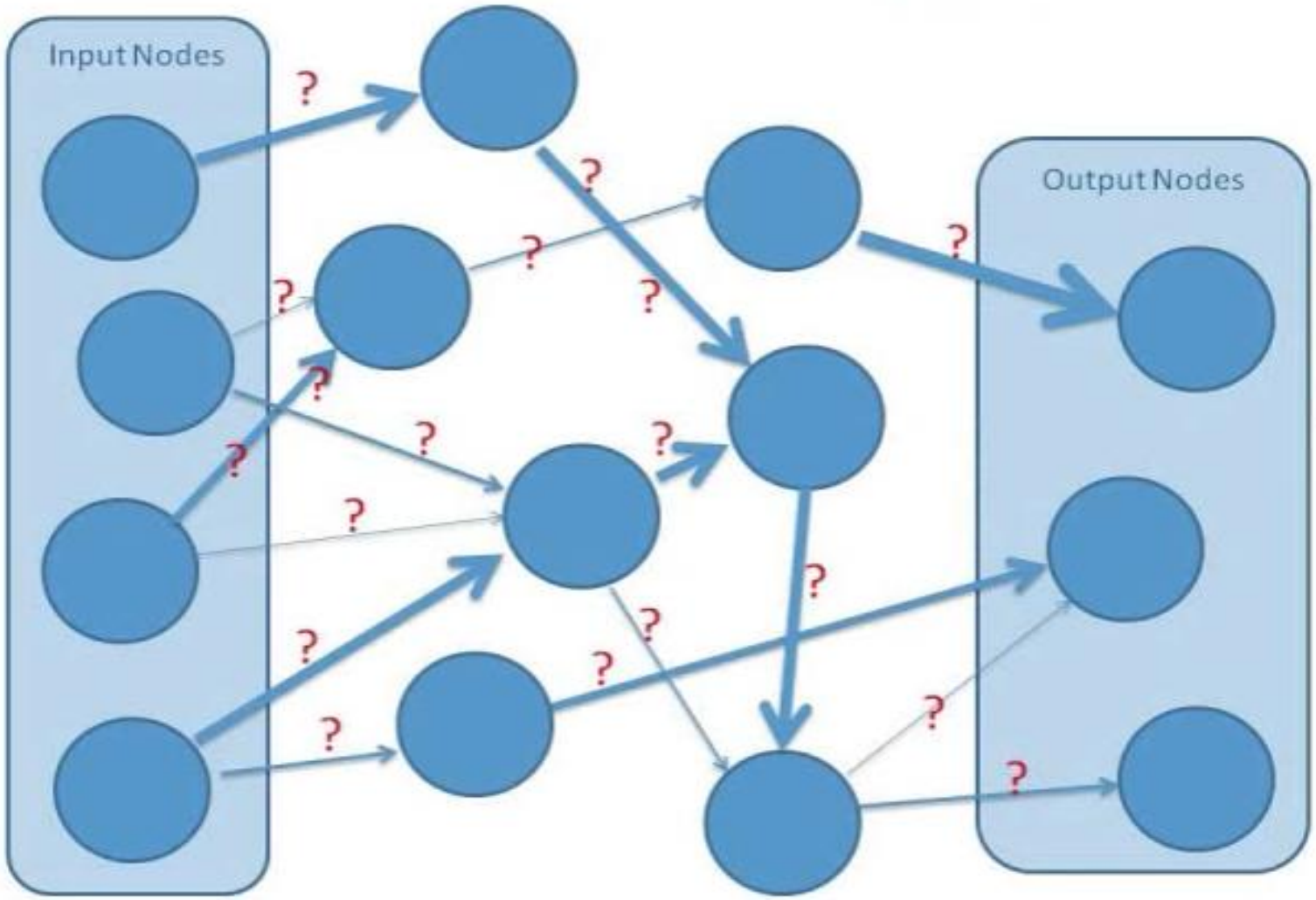
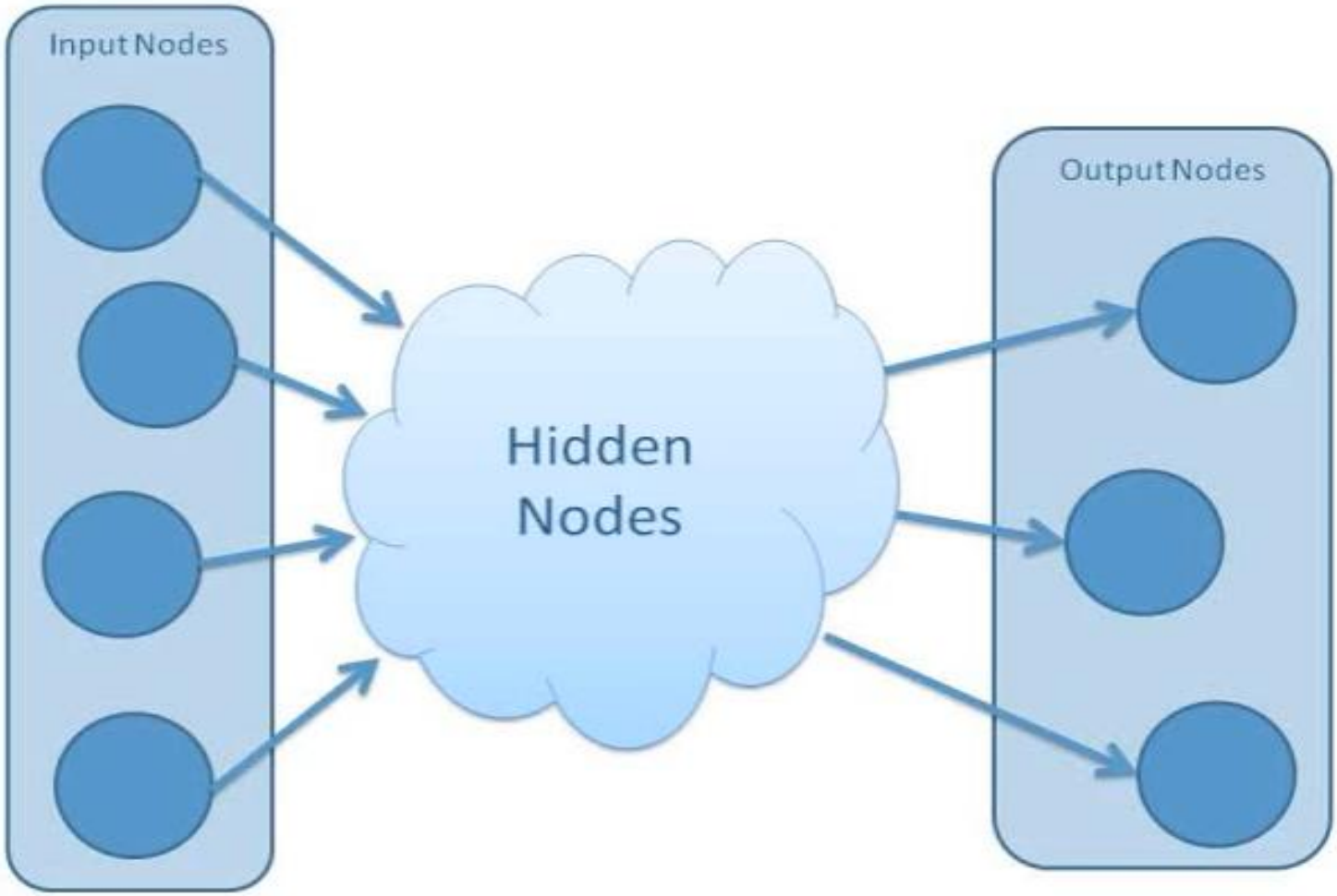
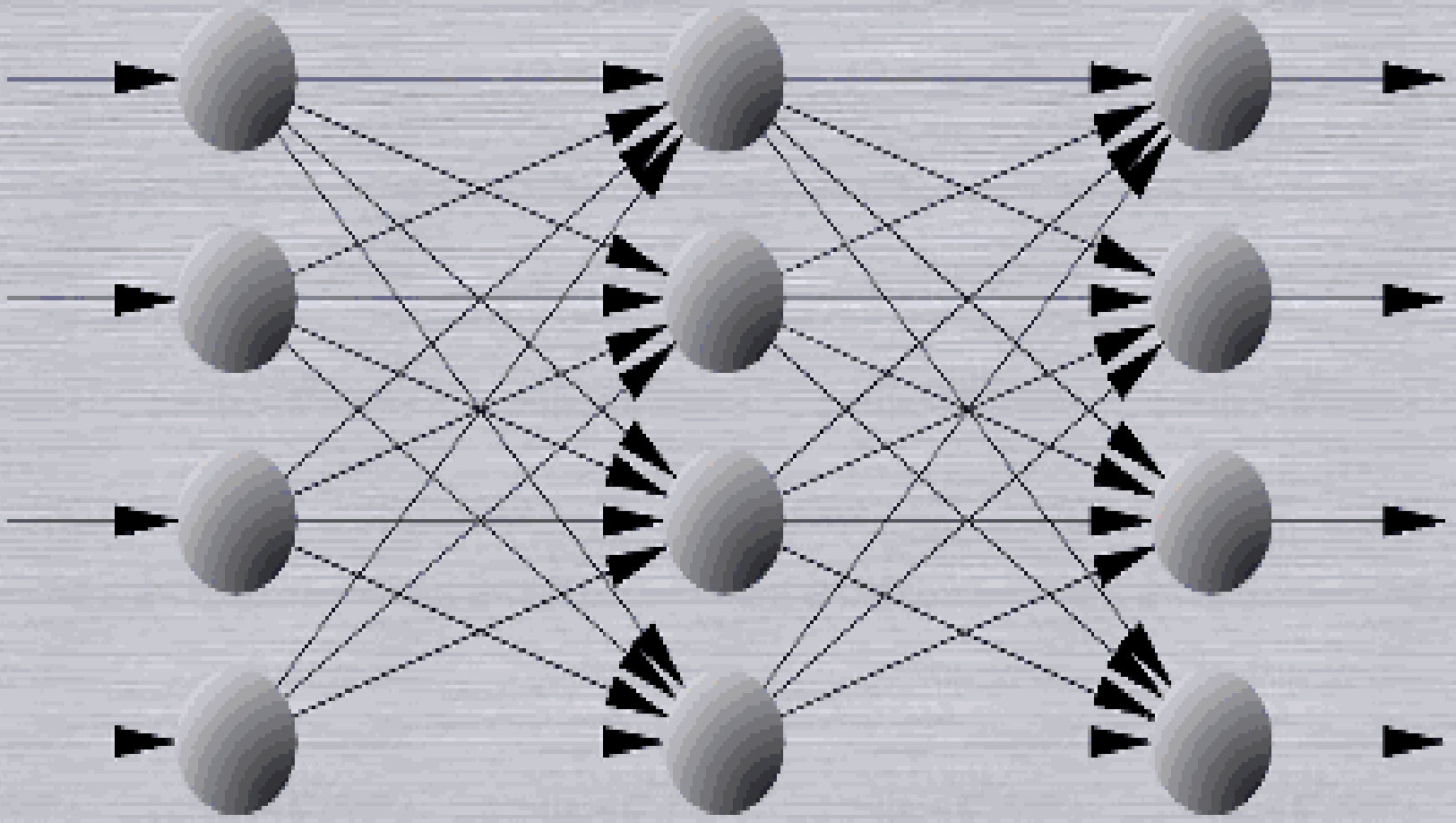


How Connection Weight Determent????

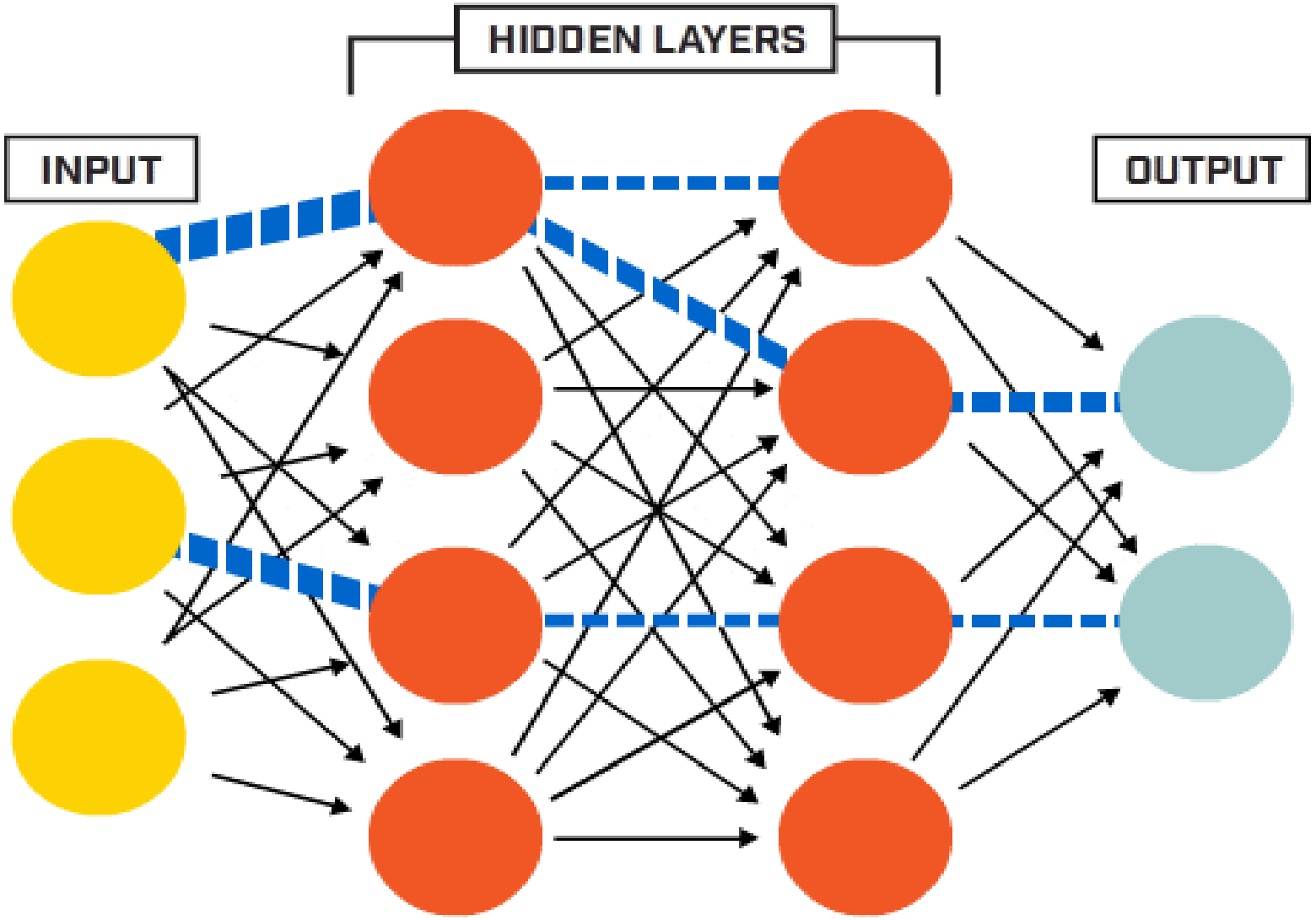

Input Nodes
Hidden Nodes
Output Nodes

Artificial Neural Networks

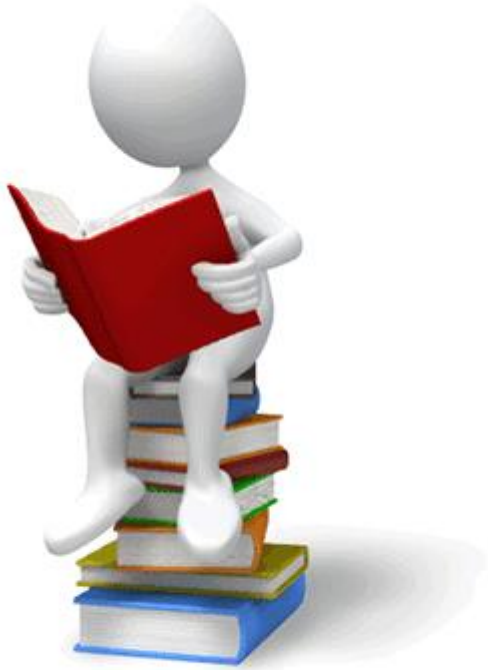


ANN

- **Input Layer**: This layer accepts input in the form of an array of numbers.
- **Hidden Layers**: Hidden layers are intermediary processing units. They are added just to increase the accuracy of the predictions.
- **Output Layer**: Results of the hidden layer are then fed to the output layer, which produces the final prediction


HIDDEN LAYERS
INPUT
OUTPUT

How We Solve Any Problem



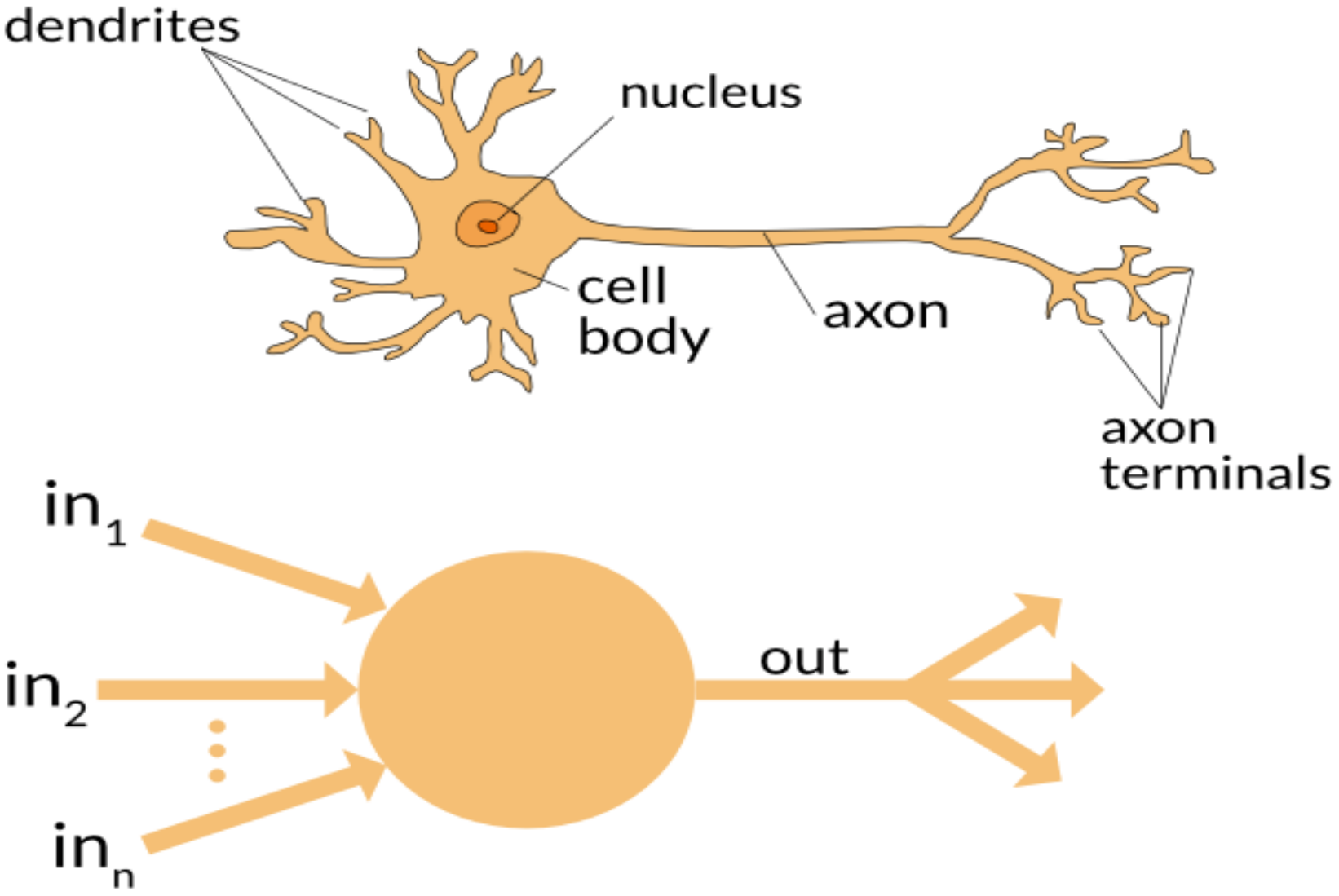
Training By Example

NEURAL NETWORK

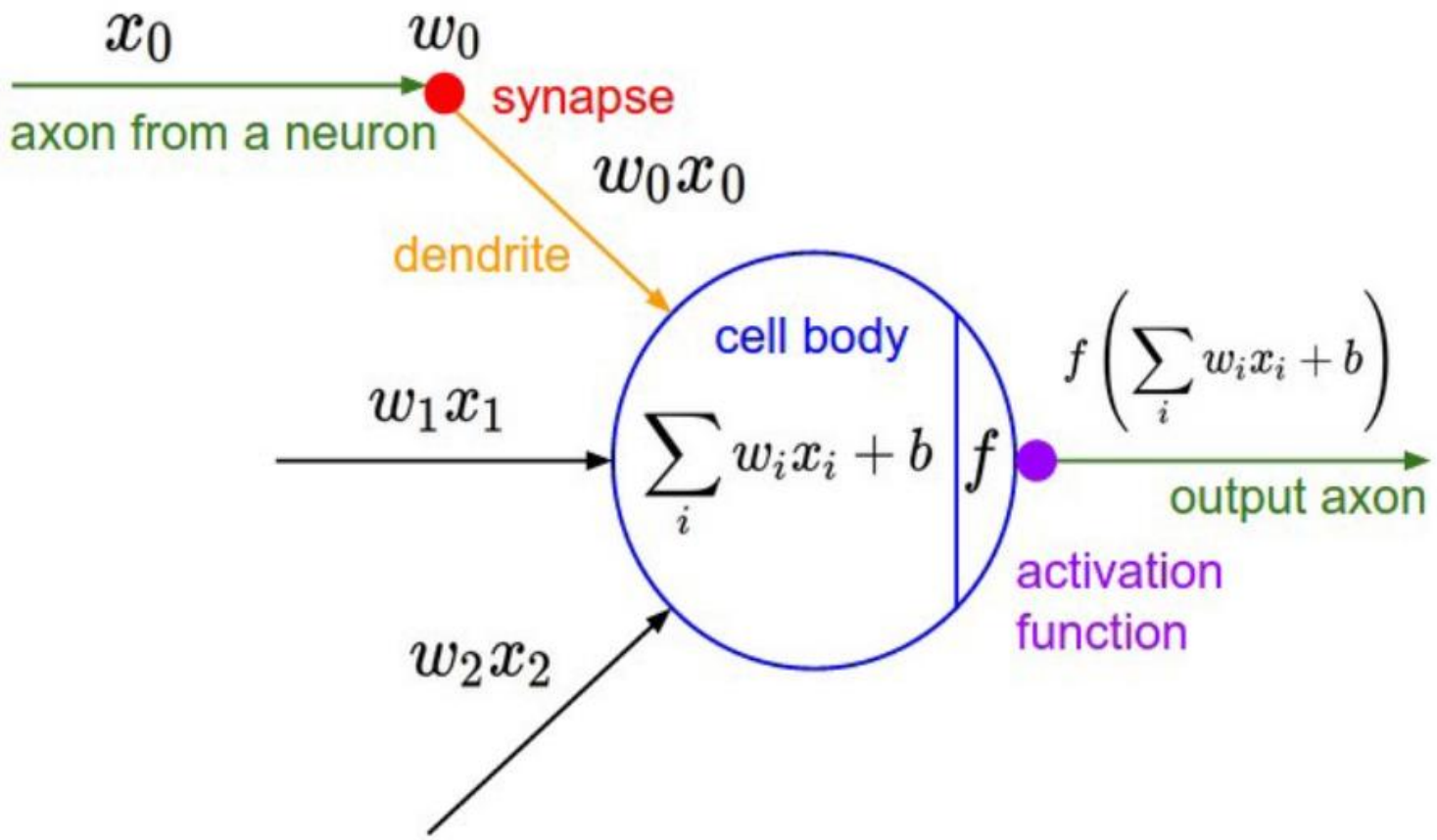
A Neural Network is a massively parallel distributed Processor that has a natural Propensity for **Storing Experimental Knowledge** and making it available for Use.

ANN-Training is Done by Example.

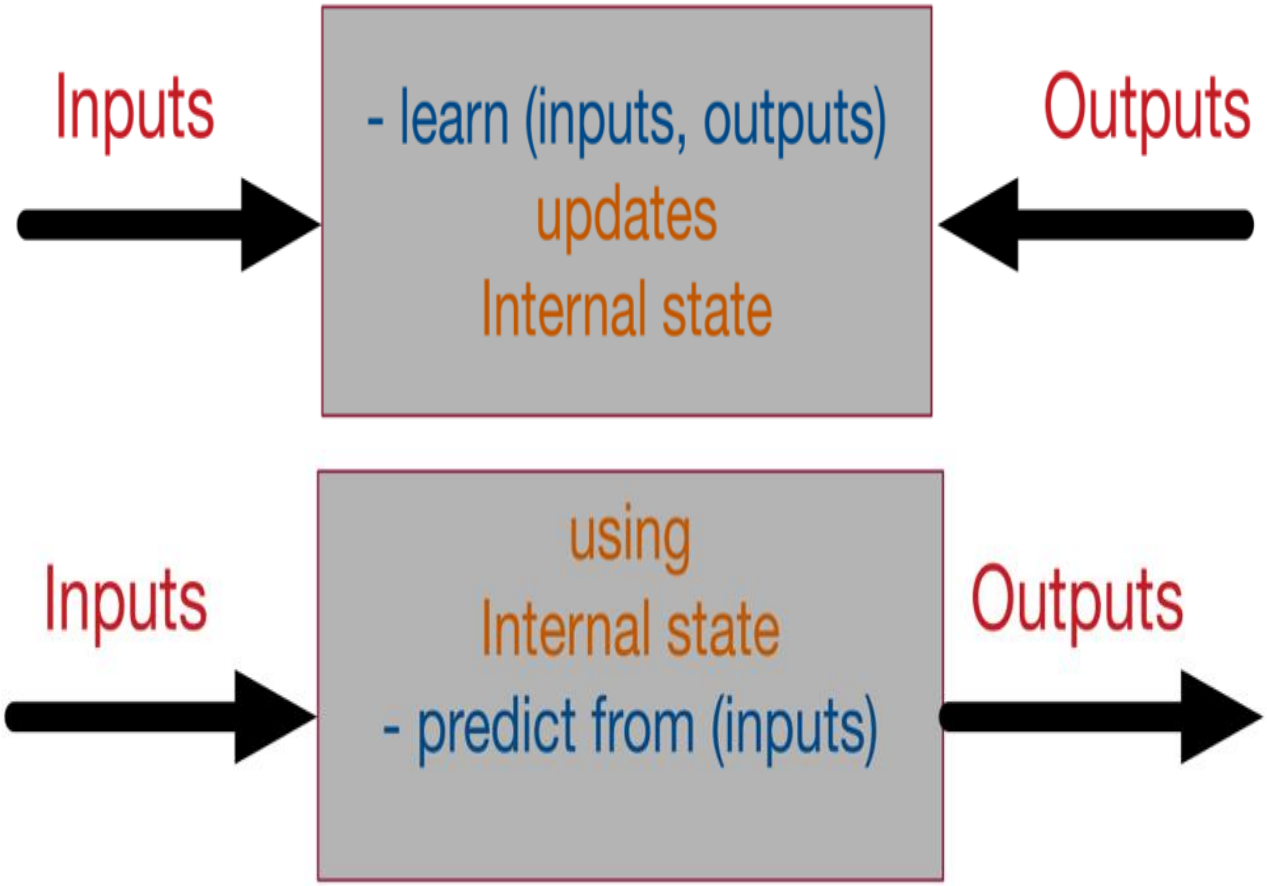
A neural network, is a collection of layers that transform the input in some way to produce an output


dendrites
nucleus
cell
body
axon
axon
terminals
in1
in2
inn
out

Mathematical model of a neuron

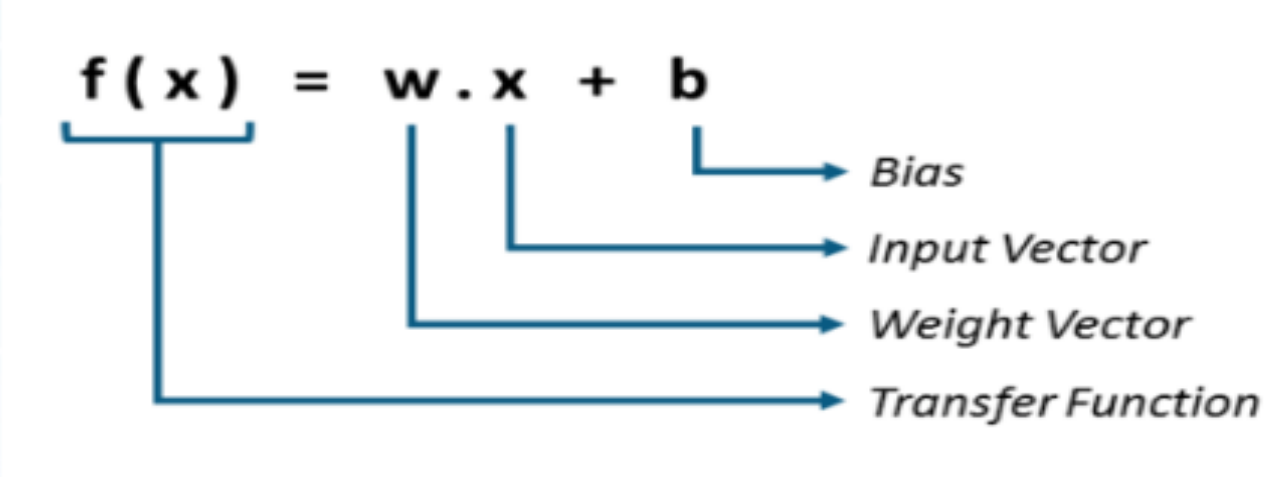


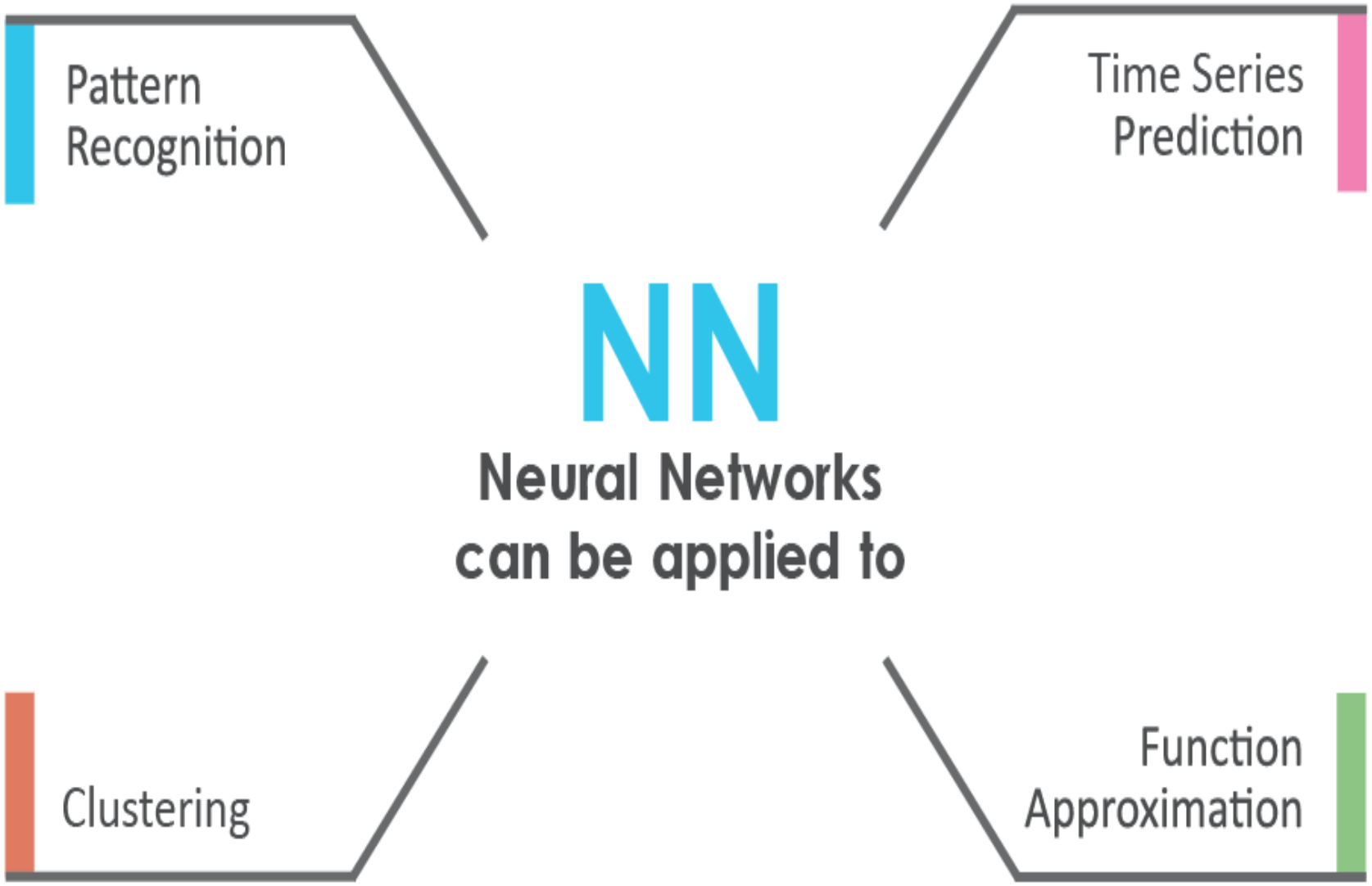
NEURAL NETWORK

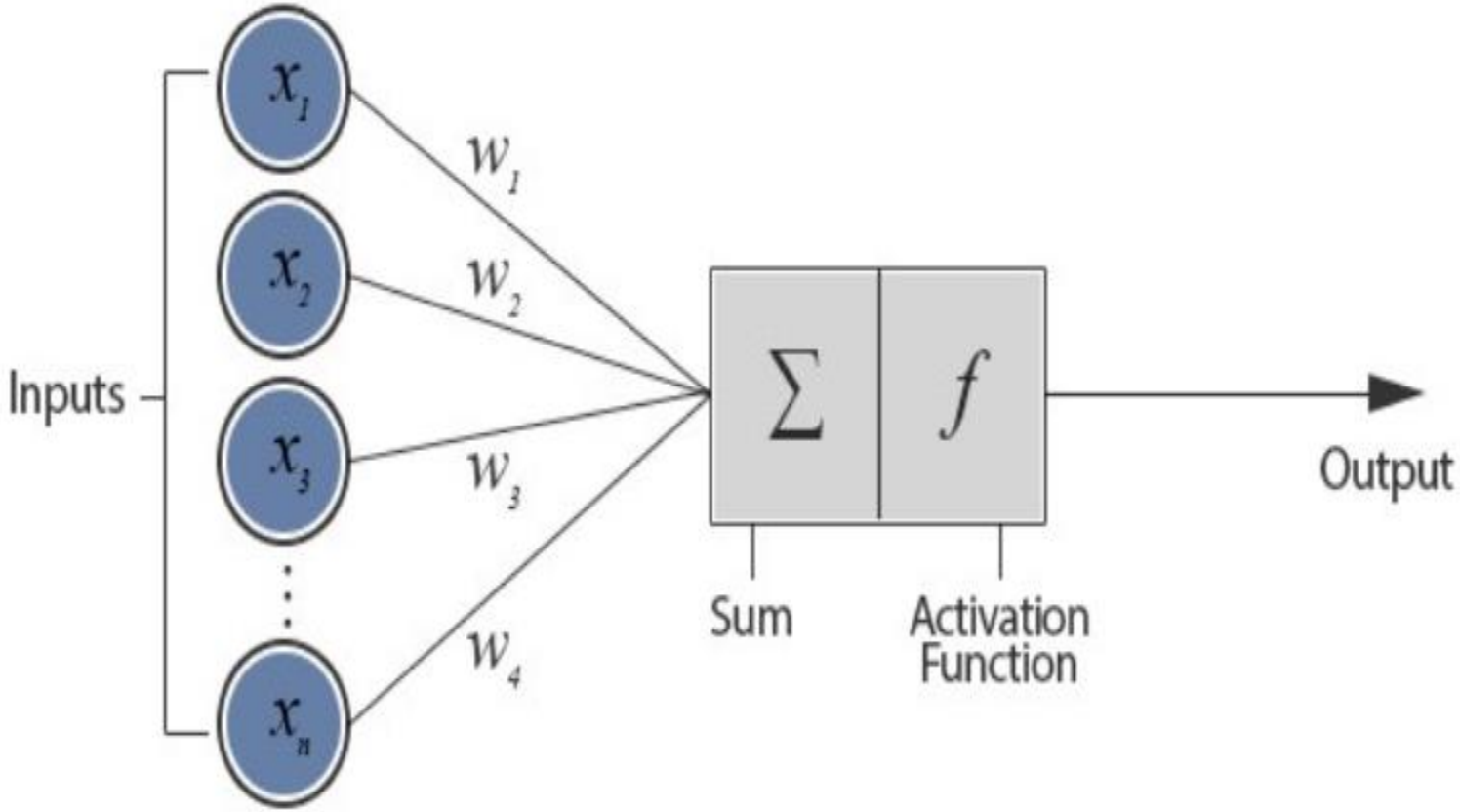


Learning Neural Net

- Weights
- Biases




Pattern Recognition
Time Series Prediction
NN
Neural Networks can be applied to
Clustering
Function Approximation



Neural networks used to determine relationships and patterns between inputs and outputs.

Data, represented by **x0,** travels through the connections between the neurons.

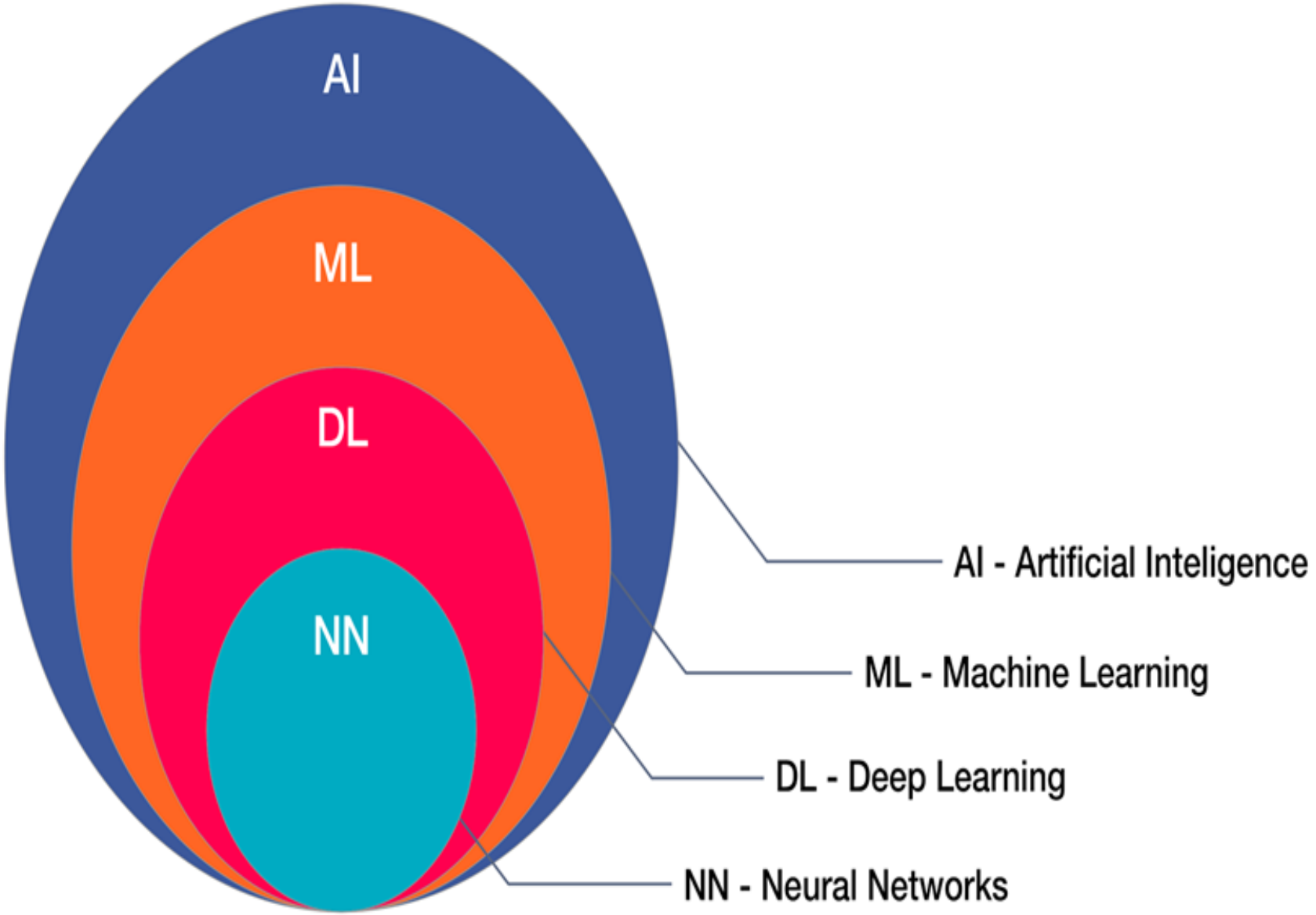
The strength of the connections are represented by their **weights** (**w0x0, w1x1**, etc).

If the signal is strong enough, it fires the neuron via its "**activation function**" and makes the neuron "**active**."

INTELLIGENCE

- Perception (Concept or Senses)
- Problem Solving
- Reasoning
- Learning
- Control Uncertainties

Intelligence is defined as general cognitive problem-solving skills.


AI
ML
DL
NN
AI - Artificial Inteligence
ML - Machine Learning
DL - Deep Learning
NN - Neural Networks

Artificial Intelligence

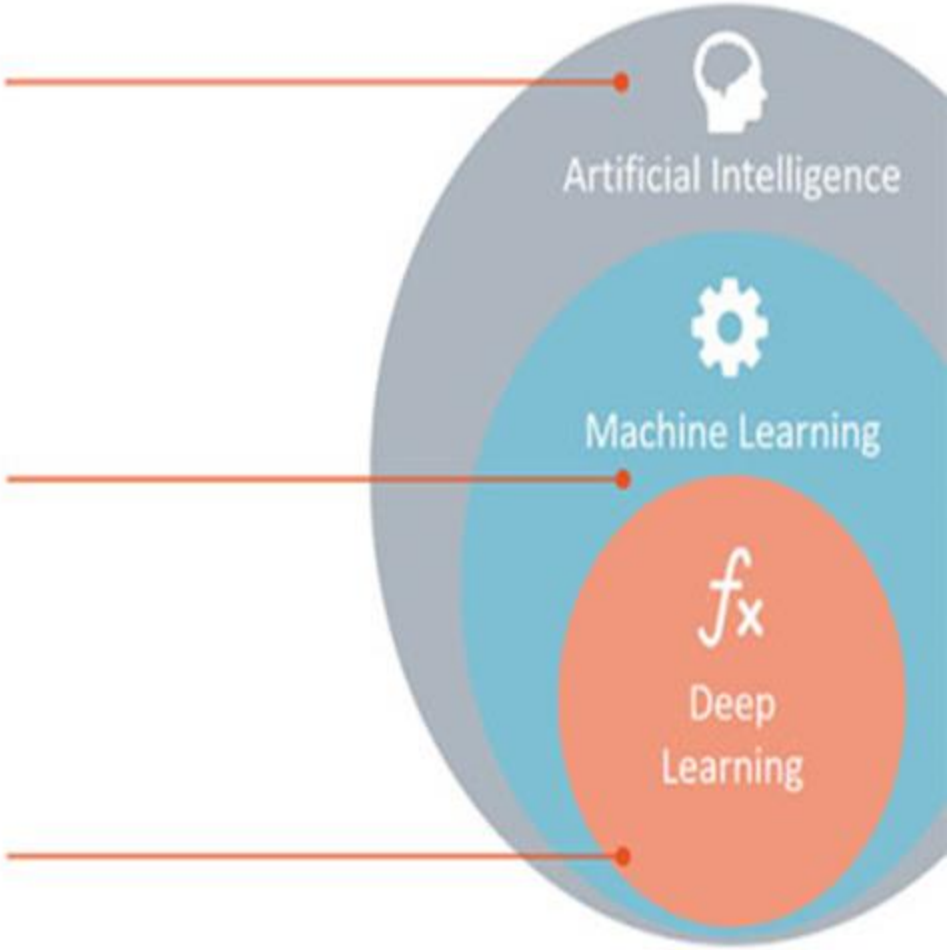
Any technique which enables computers to mimic human behavior.

Machine Learning

Subset of AI techniques which use statistical methods to enable machines to improve with experiences.

Deep Learning

Subset of ML which make the computation of multi-layer neural networks feasible.



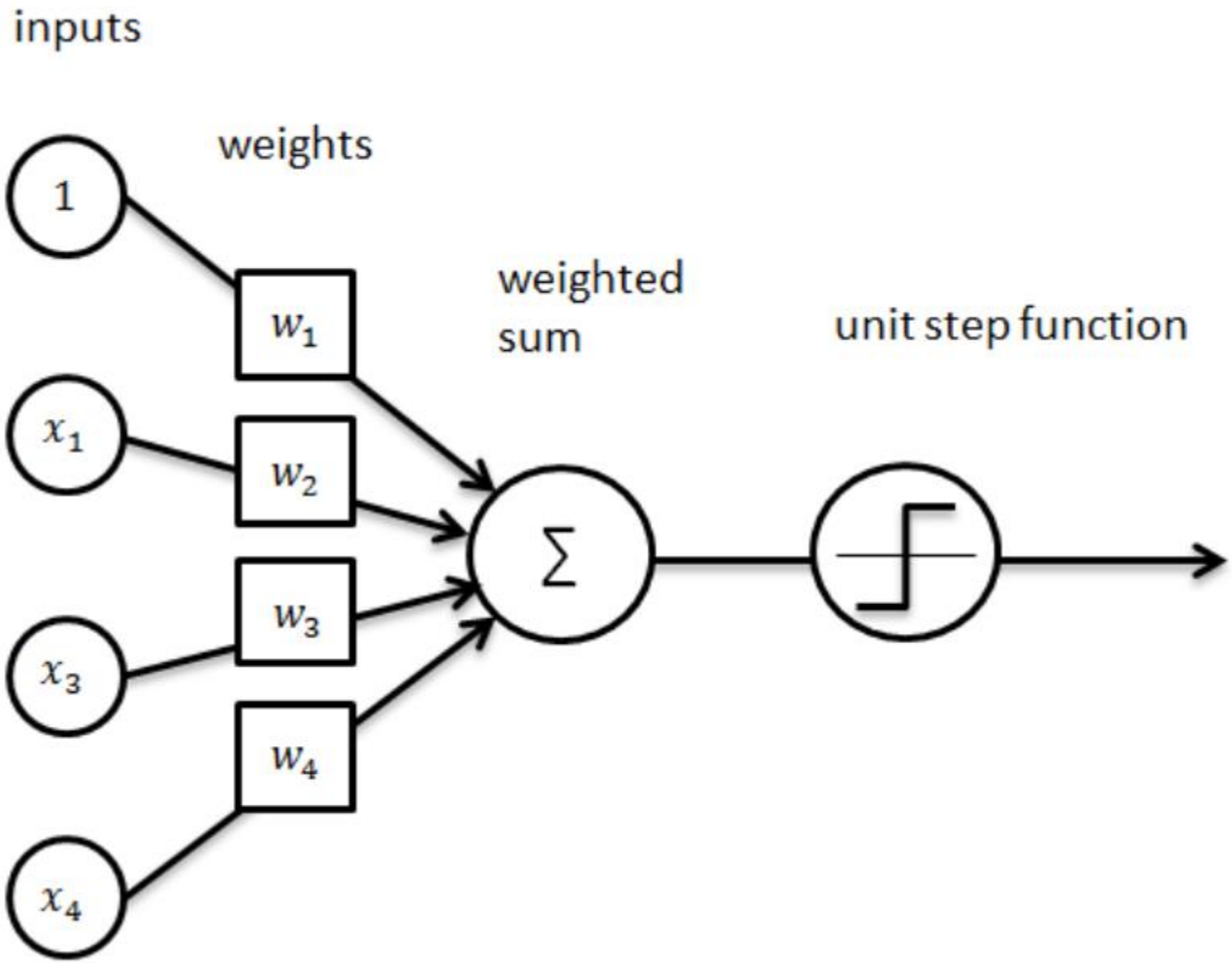
Neural networks-Applications

- identify faces,
- recognize speech,
- read your handwriting (mine perhaps not),
- translate texts,
- play games (typically board games or card games)
- control autonomous vehicles and robots

Perceptrons

Artificial neural networks were first introduced by **McCulloch and Pitts** with the introduction of the first ANN, the perceptron.

Perceptrons are simple **single-layer binary classifiers**, which divide the input space with a linear decision boundary.


inputs
weights
1
x_1
x_3
x_4
w_1
w_2
w_3
w_4
weighted sum
$\sum$
unit step function

Perceptrons

- A simple neural network architecture is called perceptron.
- The perceptron consists of two types of nodes: input nodes.
- In a perceptron, each input node is connected via a weighted link to the output Node.
- This is one layer Network and use in The case of liner separable

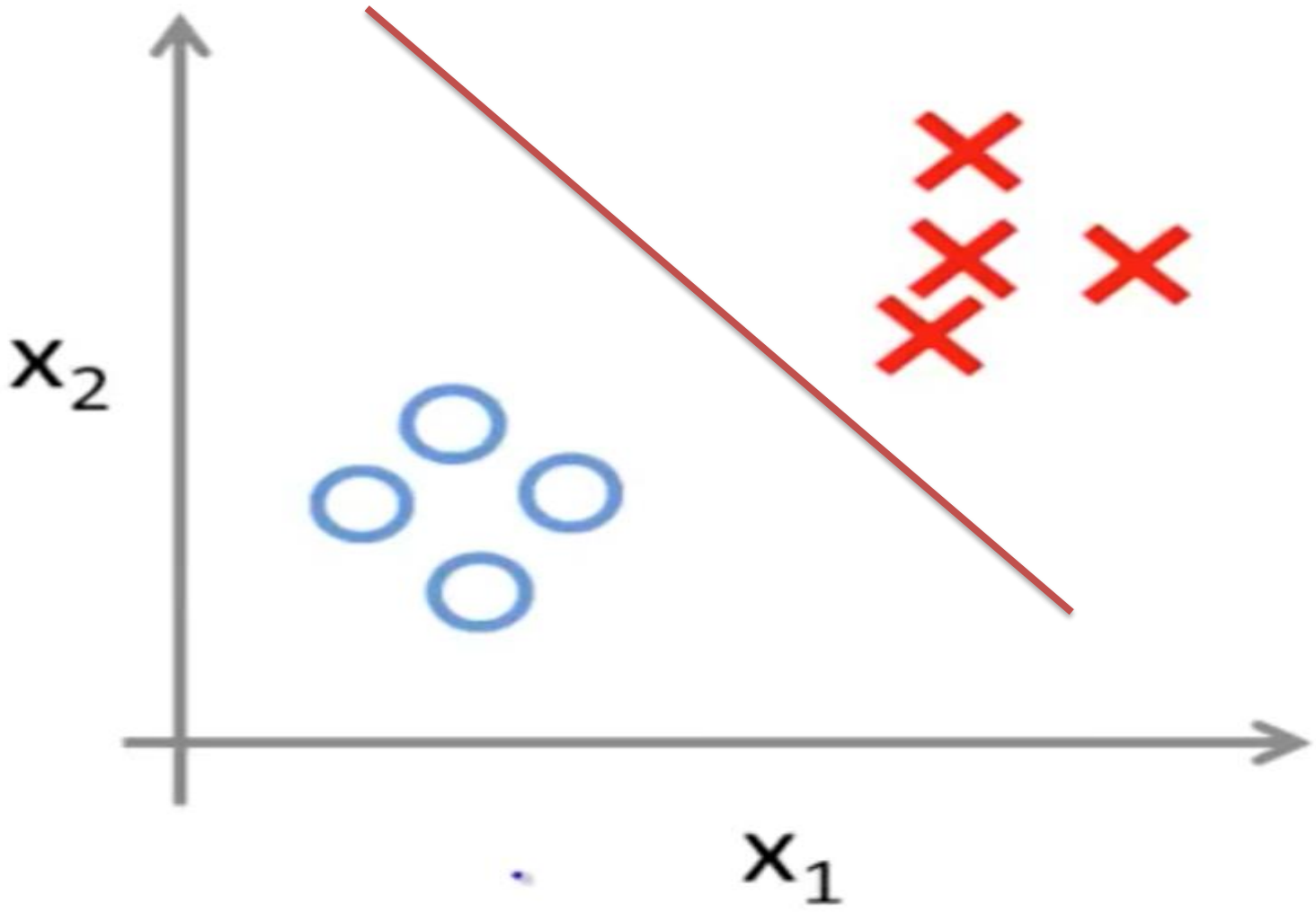
What is the perceptron actually doing

The perceptron is adding all the inputs and separating them into 2 categories, those that cause it to fire and those that don't.

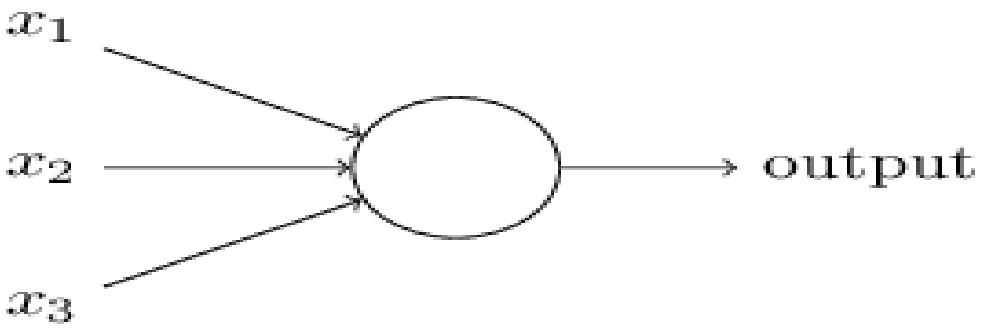
$w1x1 + w2x2 = t$, where t is the threshold

That is, it is drawing the line:
and looking at where the input point lies. Points on one side of the line fall into 1 category, points on the other side fall into the other category

Binary classification:



This is a type of artificial neuron



$$\text{output} = \begin{cases} 0 & \text{if } \sum_j w_j x_j \leq \text{ threshold} \\ 1 & \text{if } \sum_j w_j x_j > \text{ threshold} \end{cases}$$

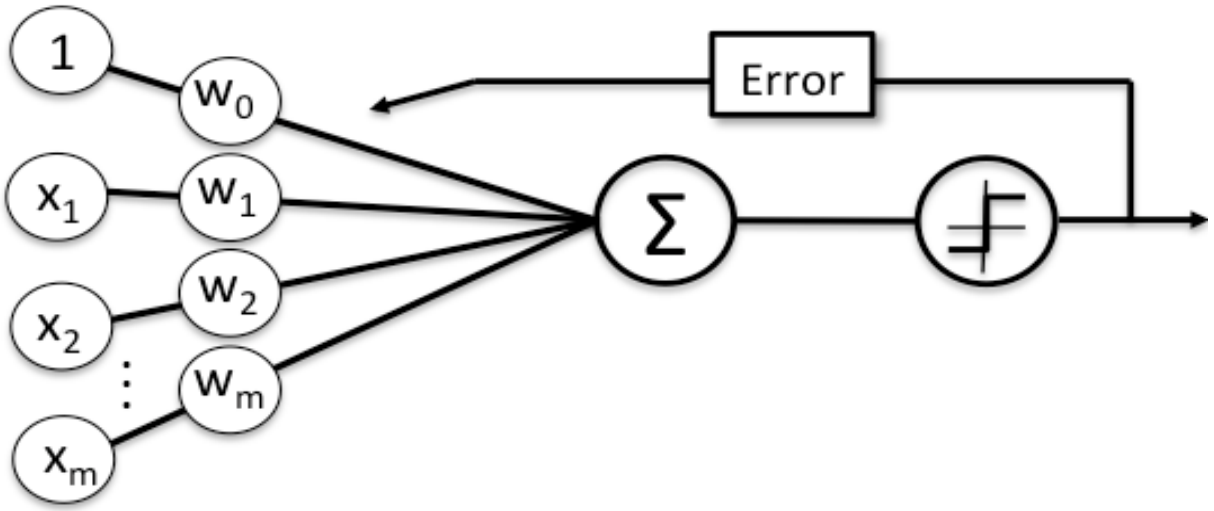
neuron fires

Input 1 (x1) = 0.6
Input 2 (x2) = 1.0
Weight 1 (w1) = 0.5
Weight 2 (w2) = 0.8
Threshold = 1.0

$$x1w1 + x2w2 = (0.6 \times 0.5) + (1 \times 0.8) = 1.1$$

The training of the perceptron

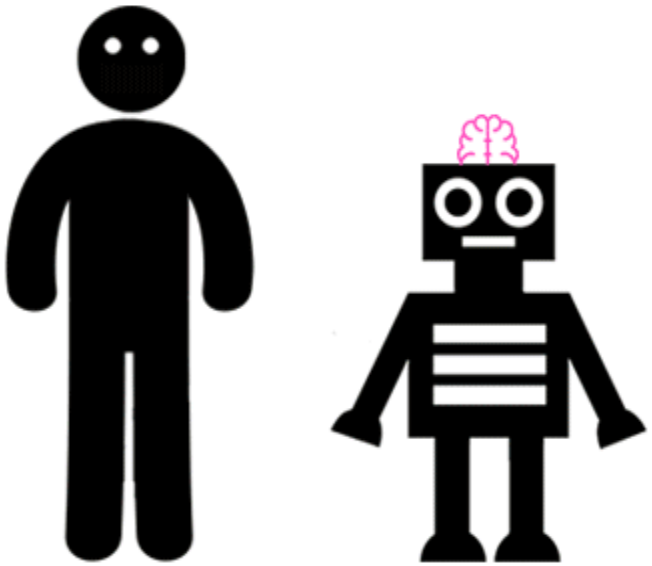
The training of the perceptron consists of feeding it multiple training samples and calculating the output for each of them. After each sample, the weights *w* are adjusted in such a way so as to minimize the *output error*, defined as the difference between the *desired* (target) and the *actual* outputs



Training in perceptrons

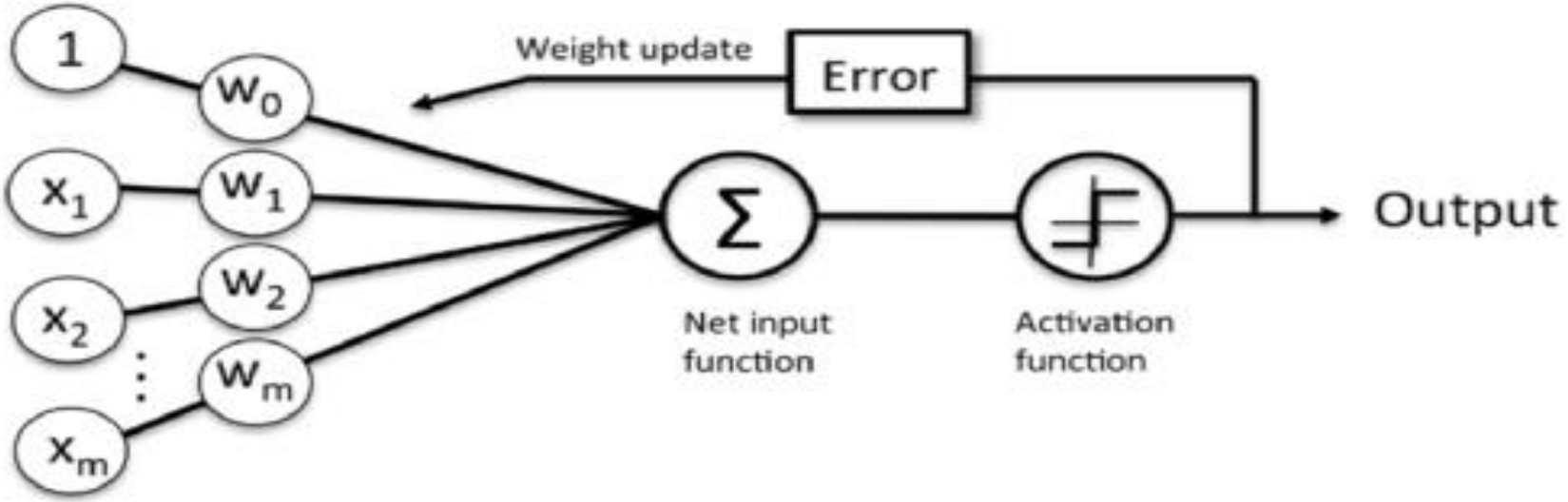
- We show examples
- Telling, “This is a **apple**. That is not a apple,” until the child learns the concept of what a apple is.
- Furthermore, if the child sees new objects that she hasn’t seen before, we could expect her to recognize correctly whether the new object is a bus or not

Training



Training in perceptrons

input vectors from a training set are presented to the perceptron one after the other and weights are modified



ERROR = DESIRED OUTPUT - GUESS OUTPUT

The error is the determining factor in how the perceptron's weights should be adjusted.

NEW WEIGHT = WEIGHT + ΔWEIGHT

ΔWEIGHT = ERROR * INPUT

NEW WEIGHT = WEIGHT + ERROR * INPUT

Perceptron Learning Rule is:

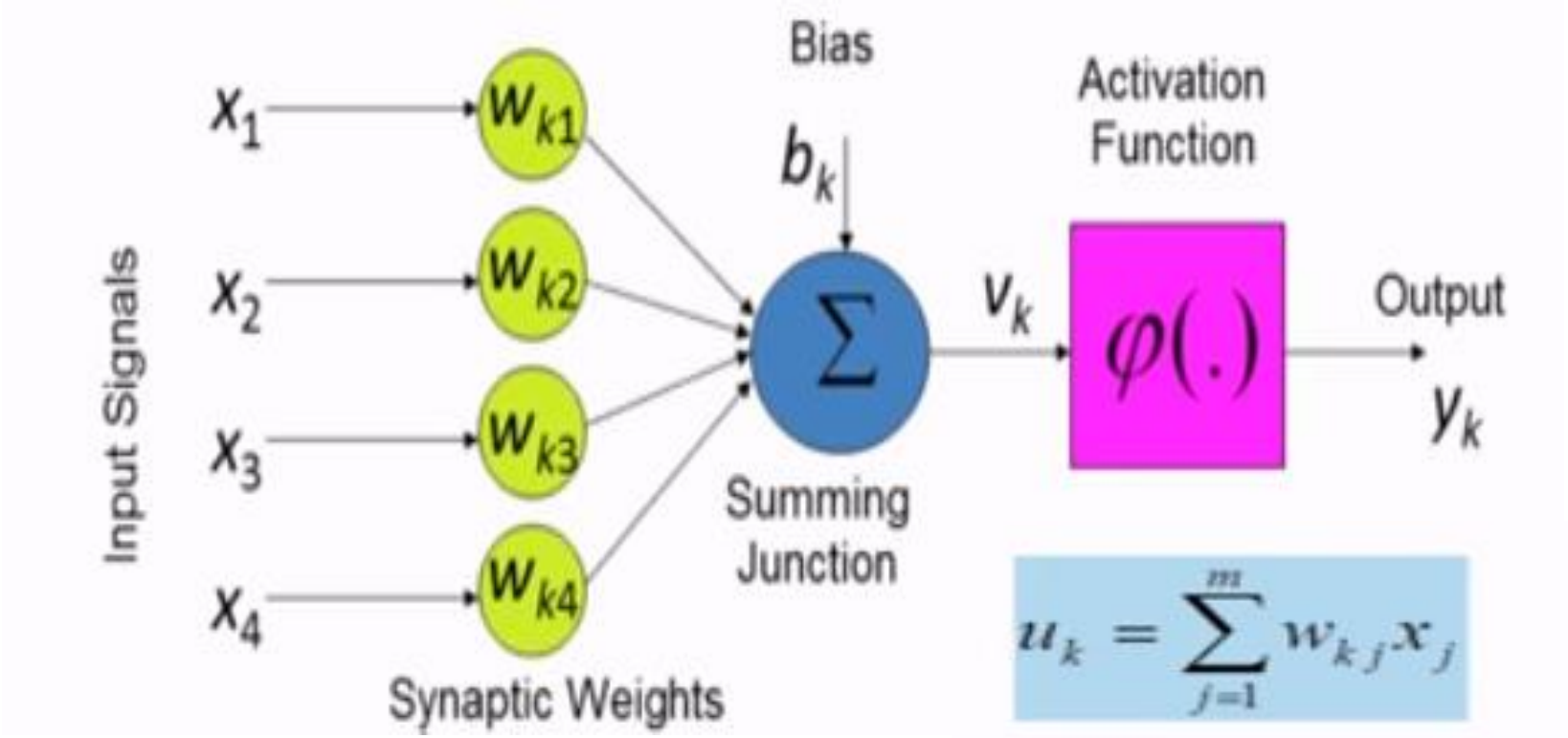
1.Wnew = Wold + e*p

2. e = t - a

3.b = bold + e

Update the **weight & bias** until it produces correct target for inputs

SINGLE-LAYER NEURAL NETWORKS (PERCEPTRONS)



Perceptron Learning Rule

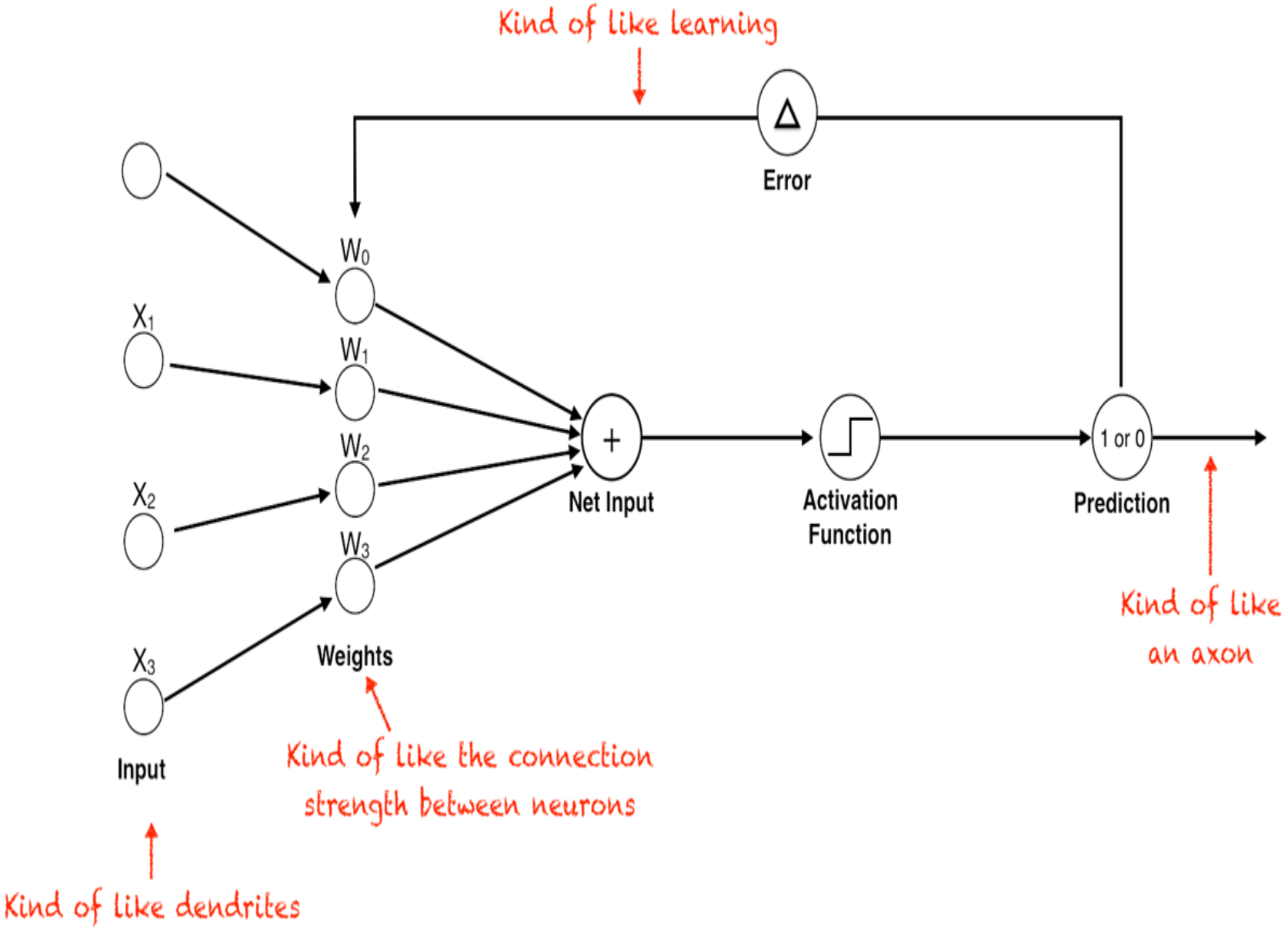
- 1. If e=0, then make a change ΔW equal 0
- 2. If e=1 the make a change ΔW equal to P’
- 3. If e=-1 the make a change ΔW equal to -P’

ΔW=(t-a)P’

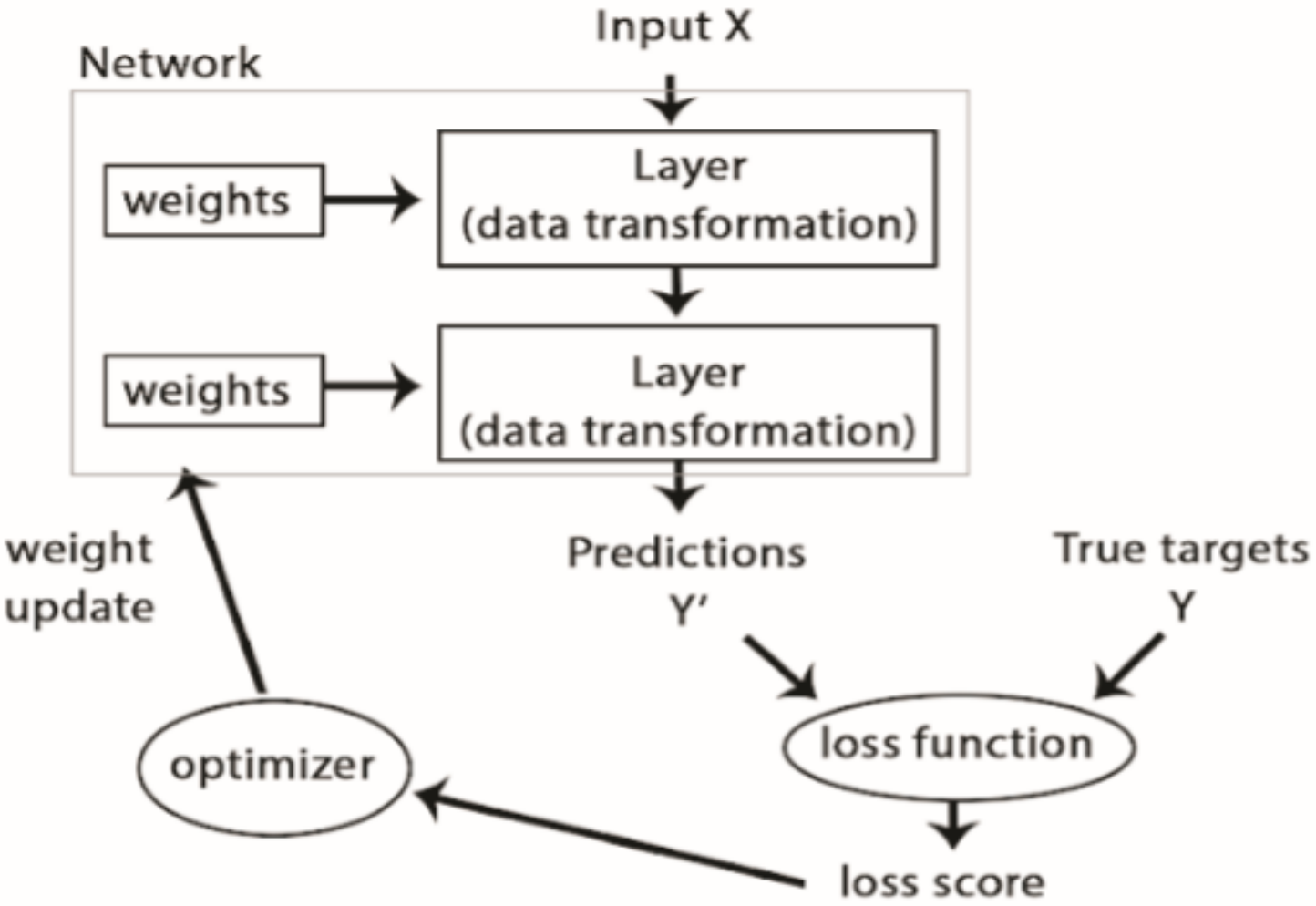
ΔW=eP’

$$\mathbf{W}new=\mathbf{W}old+\mathbf{ep}T$$

$$bnew=bold+e$$


Kind of like learning
Δ
Error
W0
X1
W1
W2
X2
W3
X3
+
Net Input
Activation Function
1 or 0
Prediction
Weights
Input
Kind of like the connection strength between neurons
Kind of like dendrites
Kind of like an axon

Neural networks



Suppose you have the following classification problem and would like to solve it with a single vector input, two-element perceptron network.

$$\left\{\mathbf{p}_1 = \begin{bmatrix}2\\2\end{bmatrix}, t_1 = 0\right\}\left\{\mathbf{p}_2 = \begin{bmatrix}1\\-2\end{bmatrix}, t_2 = 1\right\}\left\{\mathbf{p}_3 = \begin{bmatrix}-2\\2\end{bmatrix}, t_3 = 0\right\}\left\{\mathbf{p}_4 = \begin{bmatrix}-1\\1\end{bmatrix}, t_4 = 1\right\}$$

$\mathbf{W}(0)=[0 \quad 0] \quad b(0)=0$

Start by calculating the perceptron's output a for the first input vector $\mathbf{p}_1$, using the initial weights and bias.

$\alpha = hardlim(\mathbf{W}(0)\mathbf{p}1 + b(0))$

$= hardlim([0\ 0][2\ 2]' + 0)$

$= hardlim(0) = 1$

The output a does not equal the target value t_1, so use the perceptron rule to find the incremental changes to the weights and biases based on the error.

$e = t1 - \alpha = 0 - 1 = -1$

$\Delta \mathbf{W} = e\mathbf{p}^T 1 = (-1)[2\ 2] = [-2\ -2]$

$\Delta b = e = (-1) = -1$

new weights and bias using the perceptron update rules.

$\mathbf{W}new = \mathbf{W}old + \mathbf{ep}^T$

$= [0\ 0] + [-2\ -2] = [-2\ -2] = \mathbf{W}(1)$

$bnew = bold + e =$

$0 + (-1) = -1 = b(1)$

next input vector, $\mathbf{p}_2$. The output is calculated below.

$\alpha = hardlim(\mathbf{W}(1)\mathbf{p}2 + b(1))$

$= hardlim([-2\ -2][1\ -2]\ -1)$

$= hardlim(1) = 1$

On this occasion, the target is 1, so the error is zero. Thus there are no changes in weights or bias, so $\mathbf{W}(2) = \mathbf{W}(1) = [-2\ -2]$ and $b(2) = b(1) = -1$.

Basic Element Of ANN

- Input and Output Nodes
- Weights
- Activation Function

- Type of Neural Network
- Type of Activation Function
- Type of Learning Rule or Training

Neural-Network