Soft Computing vs. Hard Computing

1. The biological processes fascinated scientists to solve real world problems by simulating the processes to robust algorithms and solve problems like a human mind in uncertain environment with limited information whereas the conventional algorithms (hard computing) fail to solve due to the strict principles. For example, conventional algorithms fail when input is not exact whereas SC deals with inexact information and generate a nearly optimal solution for the problem.

2. Example: If we need to find out whether Bob is honest. A hard computing algorithm would give an answer that is Yes or No (1 or 0 in binary) whereas a SC technique (Fuzzy Logic) would give an answer with membership degree such as extremely honest (1), very honest (0.85), sometimes honest (0.35), extremely dishonest (0.00), like a human.

Branches of Soft Computing

1. **Fuzzy Logic**

2. **Neural Network**

3. **Evolutionary Computation**

Neural Network is a network of artificial neurons**, inspired by biological network of neurons** that uses mathematical models as information processing units to discover patterns in data which is too complex to notice by human.

Biological Neuron

A nerve cell neuron is a special biological cell that processes information. According to estimation, there are huge number of neurons, approximately 10^{11} with numerous interconnections, approximately 10^{15}.

Schematic Diagram
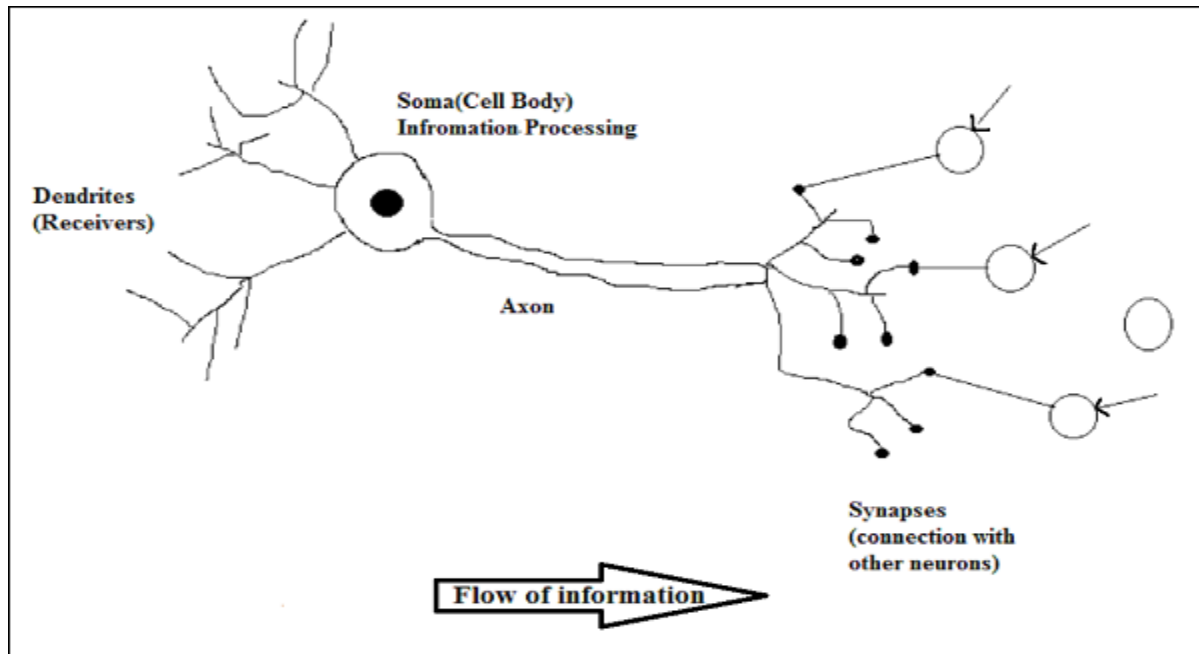

Working of a Biological Neuron

As shown in the above diagram, a typical neuron consists of the following four parts with the help of which we can explain its working –

- **Dendrites** – They are tree-like branches, responsible for receiving the information from other neurons it is connected to. In other sense, we can say that they are like the ears of neuron.

- **Soma** – It is the cell body of the neuron and is responsible for processing of information, they have received from dendrites.

- **Axon** – It is just like a cable through which neurons send the information.

- **Synapses** – It is the connection between the axon and other neuron dendrites.

ANN vs BNN

The similarities based on the terminology.

Biological Neural Network	Artificial Neural Network
Soma	Node
Dendrites	Input
Synapse	Weights or Interconnections
Axon	Output
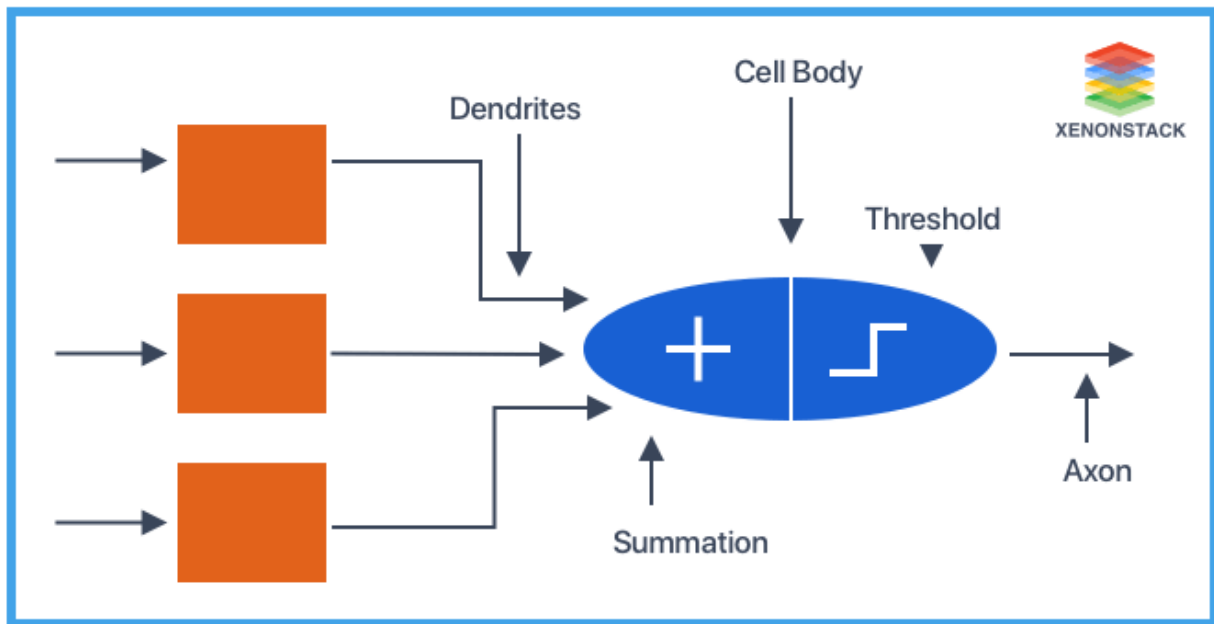
The following table shows the comparison between ANN and BNN based on some criteria mentioned.

Criteria	BNN	ANN
Processing	Massively parallel, slow but superior than ANN	Massively parallel, fast but inferior than BNN

Size	10^{11} neurons and 10^{15} interconnections	10^2 to 10^4 nodes mainly depends on the type of application and network designer
Learning	They can tolerate ambiguity	Very precise, structured and formatted data is required to tolerate ambiguity
Fault tolerance	Performance degrades with even partial damage	It is capable of robust performance, hence has the potential to be fault tolerant
Storage capacity	Stores the information in the synapse	Stores the information in continuous memory locations

Model of Artificial Neural Network

The following diagram represents the general model of ANN followed by its processing.
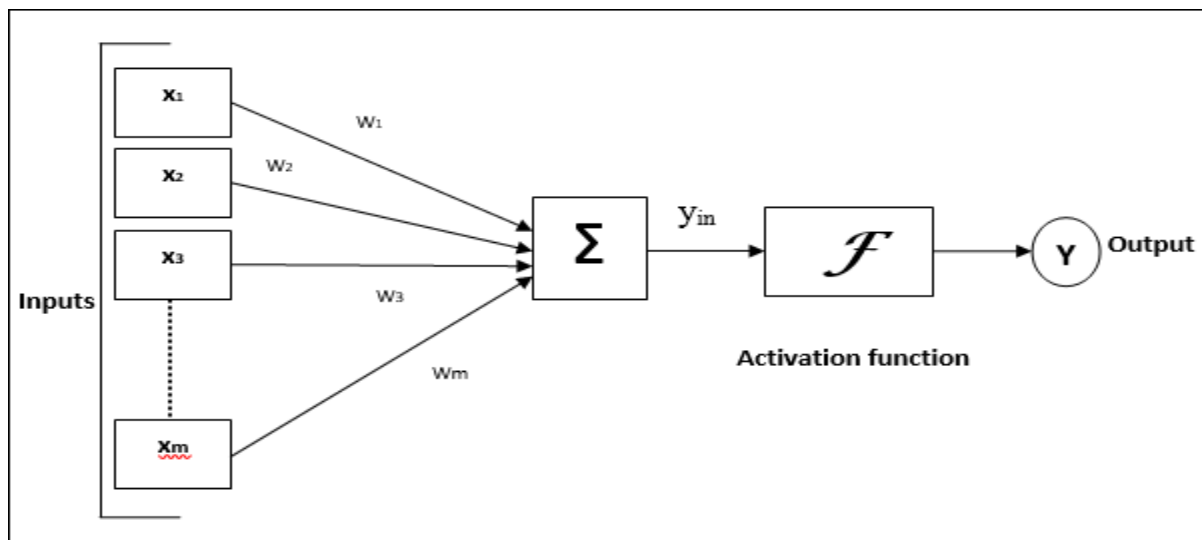
For the above general model of artificial neural network, the net input can be calculated as follows −

$$y_{in} \ = \ x_1.w_1 \ + \ x_2.w_2 \ + \ x_3.w_3 \ \ldots \ x_m.w_m$$

i.e., Net input $\ y_{in} \ = \ \sum_i^m x_i.w_i$

The output can be calculated by applying the activation function over the net input.

$$Y \ = \ F(y_{in})$$

Output = function $\ net\ input\ calculated$