Models of Neuron:

A neuron is an information processing unit that is fundamental to the operation of a Neural Network (NN)

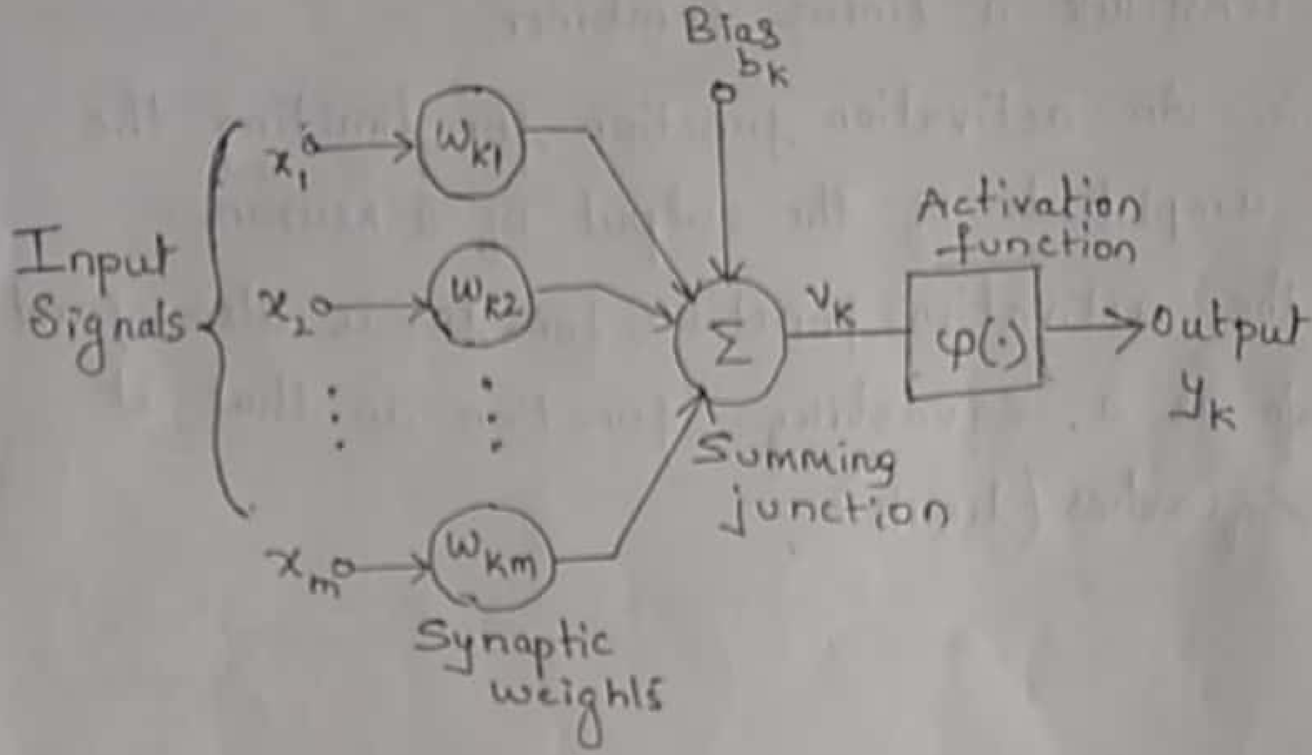


Fig: Nonlinear model of a neuron

The figure shows the model of a neuron, which forms the basis for designing (artificial) NN. Here we identify three basic elements of the neuronal model.

1. A set of synapses or connecting links each of which is characterized by a weight or strength of it's own. Specially a signal x_j at the input of synapse j connected to neuron K is multiplied by the synaptic weight w_{kj}

2. An adder for summing the input signals, weighted by the respective synapses of the neuron; the operations described here constitute a linear combiner.

3. An activation function for limiting the amplitude of the output of a neuron.

The activation function ~~for li~~ is also referred to as a squashing function in that it squashes (limits)

Refer - Page 33 [write the equations].

Types of Activation function:

The activation func denoted by $\varphi(v)$ defines the output of a neuron in terms of the induced local field v.

Three basic types of activation functions:

① **Threshold function:**

The activation func is

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

This is commonly referred to as Heaviside function.

The output of neuron k is given by

$$y_k = \begin{cases} 1 & \text{if } v_k \geq 0 \\ 0 & \text{if } v_k < 0 \end{cases}$$

where v_k is the induced local field of the neuron.

$$v_k = \sum_{j=1}^{m} w_{kj} x_j + b_k$$

② **Piecewise-linear func:**

$$\varphi(v) = \begin{cases} 1 & v \geq +\frac{1}{2} \\ v & +\frac{1}{2} > v > -\frac{1}{2} \\ 0 & v \leq -\frac{1}{2} \end{cases}$$

3. Sigmoid function :

The graph is S-shaped. & this is the most common form of activation func used in the construction of ANN.

The sigmoid func is the logistic function defined by

$$\phi(v) = \frac{1}{1+\exp(-av)}$$

Scanned with CamScanner

Neural Networks Viewed as Directed Graphs:

A Signal-flow graph is a network of directed **links** (branches) that are inter connected at certain points called **nodes**.

A typical node j has an associated node signal x_j

The 3 basic rules.

Rule 1: A signal flows along a link only in the direction defined by the arrow on the link.

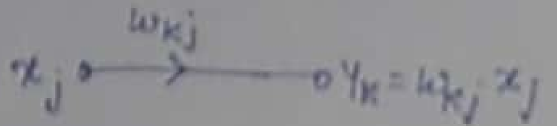
Two different types of links may be

(i) Synaptic links, whose behavior is governed by a linear input-output relation. The node signal x_j is multiplied by the Synaptic weight w_{kj} to produce the node signal y_k. fig (a).

(ii) Activation links, whose behavior is governed by a nonlinear input-output relation. fig (b) where $\phi(\cdot)$ is the non-linear activation func

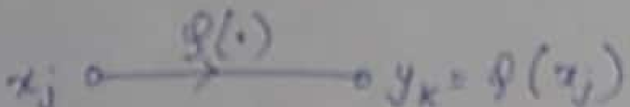
Rule 2: A node signal = Algebraic sum of all signals fig (c). case of Synaptic convergence or fan-in.

Rule 3: The signal at a node is transmitted to each outgoing link originating from that node, with the transmission being entirely independent of the transfer func of the outgoing links fig (d) for the case of Synaptic divergence or fan-out.



Synaptic links

fig (a)



Activation links

fig (b)

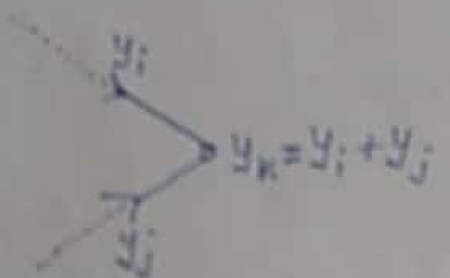


fig (c) Synaptic convergence

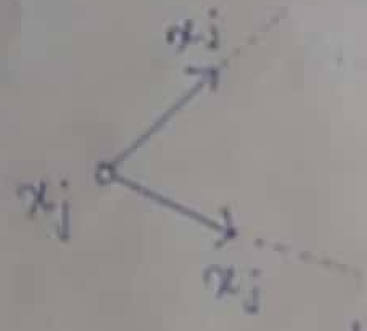
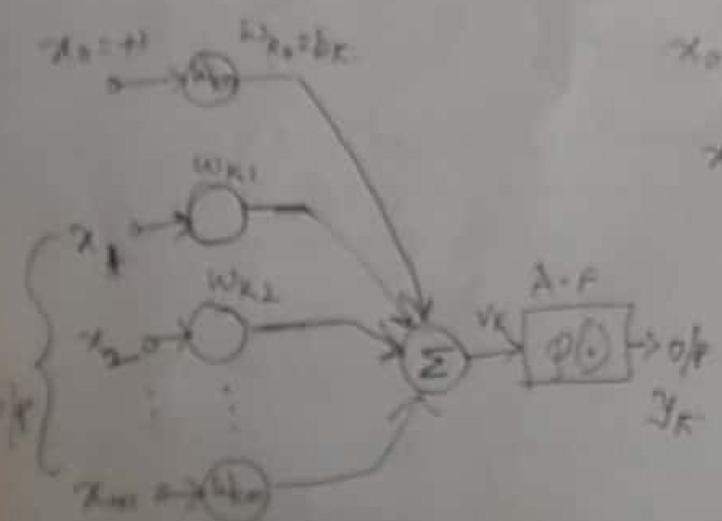
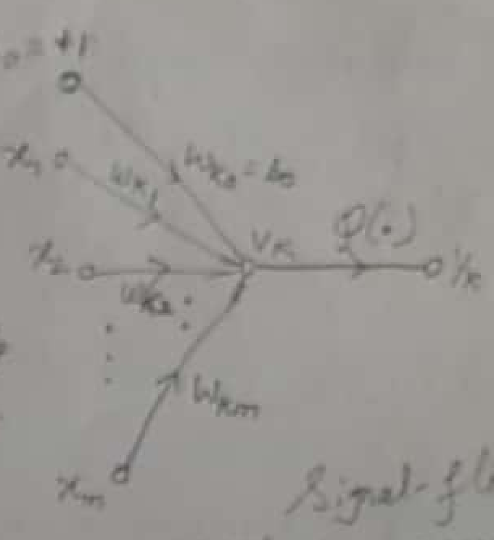


fig (d) Synaptic divergence

fig: Illustrating basic rules for the construction of Signal-flow graphs.





Signal-flow graph of a neuron.

FEEDBACK :

Feedback is said to exist in a dynamic system whenever the output of an element in the system influences in part the input applied to that particular element, thereby giving rise to one or more closed paths for the transmission of signals around the system.

Feedback occurs in almost every part of the nervous system.

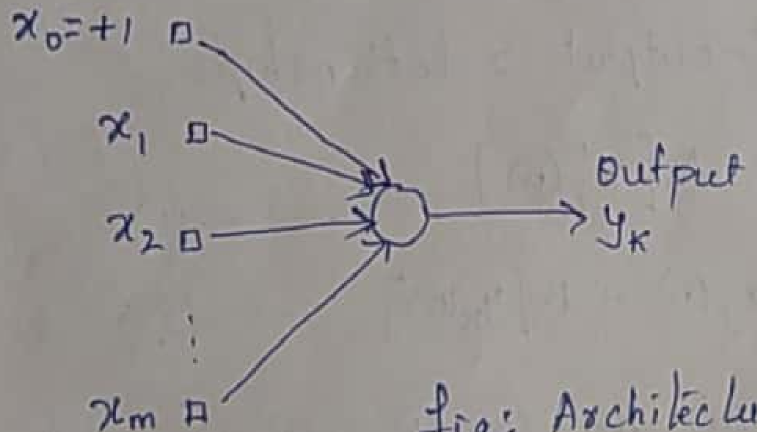


fig: Architectural graph of a neuron.

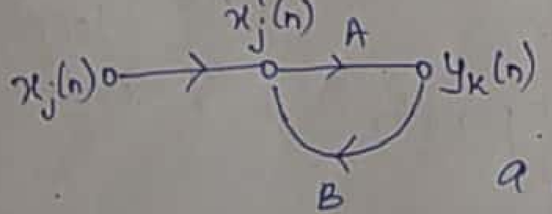


fig: Signal-flow graph of a single-loop feedback system.

fig shows the signal flow graph of a single-loop feedback system.

where the input signal $x_j(n)$, internal signal $x_j'(n)$ & the output signal $y_k(n)$ are functions of the discrete-time variable n.

The system is assumed to be linear, consisting of a forward path & a feedback path that are characterized by the "operators" A & B.

The input-output relationships:

$$y_k(n) = A[x_j'(n)] \quad \text{—— (1)}$$

$$x_j'(n) = x_j(n) + B[y_k(n)] \quad \text{—— (2)}.$$

Eliminating $x_j'(n)$ btn eqn (1) & (2) we get

$$y_k(n) = \frac{A}{1-AB}[x_j(n)] \quad (3)$$ where $A/1-AB$ → closed loop operator.

AB as the open-loop operator. Refer - Page - 41 4 /

NOTE: Greek symbols & pronounciation