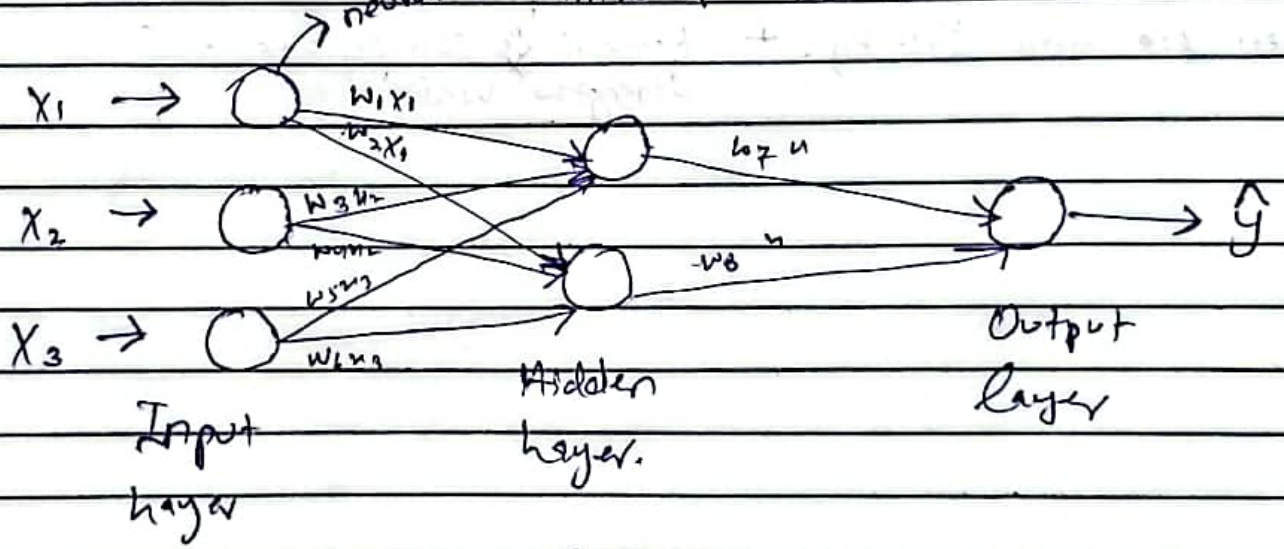
Artificial Neural Networks (ANN)

- Brain is biological neural network consisting of neurons. (approx 100 billions neurons)
  - Together neurons form a network and communicate through electro-chemical signals.
  - neuron sends & receives signals from other neurons through connections called synapses.
  - Each neuron sends & receives 10^4 of synapses.

- Neural Networks can be used for classification, clustering & numeric prediction task.
- Deep learning (Norbert Wiener)
  - Back in 1940's.
  - study to control or regulation mechanism in humans & machines.

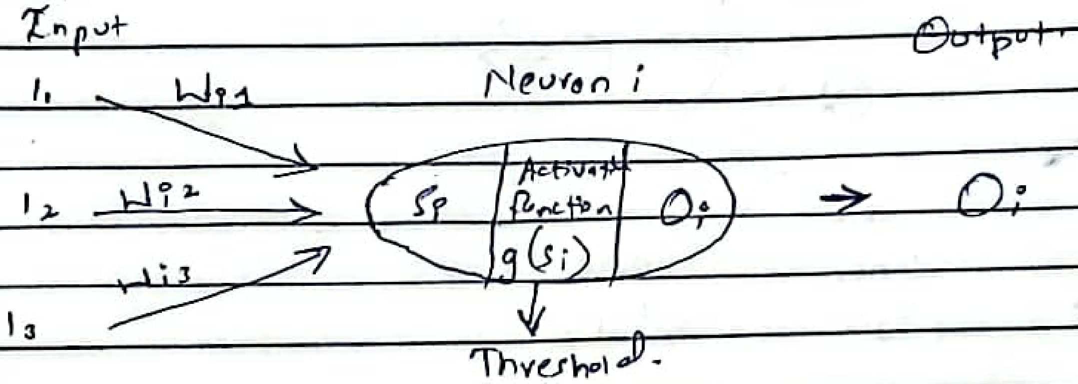


- Activation function (Jb neuron signals bhejtey hain, activation function decides output signal bhejna hy ya nahi).
  - It uses threshold. If signal threshold sy zaida, output bheja jata hy.

- Common functions are → - Threshold function
  - ~~Linear function~~
  - Sigmoidal function

•– ANN layers

Input layer → patterns communicated to 1 or more hidden layers.
Hidden layer → Process input by weighted connections + pass it on if crossed threshold.
Output layer → gives a result.



•– Perceptron (modeled neuron)

- ANN weights can be → • Set using apriori domain knowledge. (↑ not used.)
  - Training kay beech continuously adjust kiya ja skein. e.g., ANN trains so weights apne aap update
    - Supervised learning
    - Unsupervised learning

•– ANN Architectures

Mainly are → • Feed-forward neural networks (input passes in 1 direction only)
- Recurrent neural networks (temporarily remember previous ~~input events~~ + feedback connections)

Feed-Forward

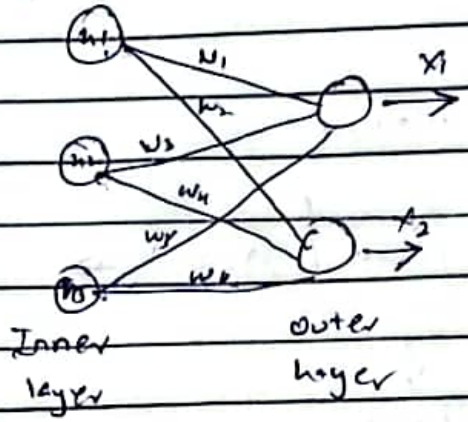
Recurrent

no feedback connections.

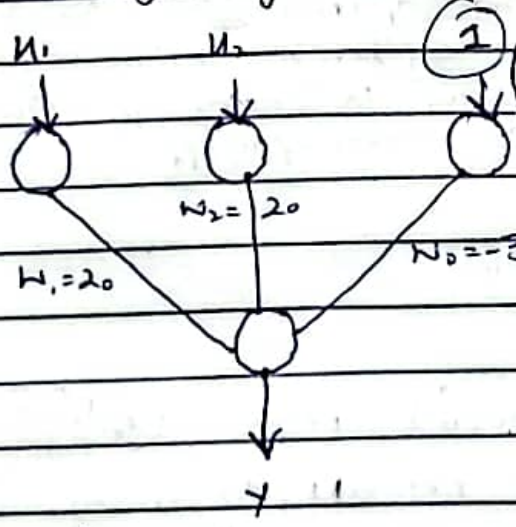
- Feed Forward → • Zero or multiple hidden layers.
  • No feedback connections

- Single-layer perceptron
- Multi-layer perceptron (MLP)

Single layer Perceptron.



- Solving Logical AND Problem



x_1	x_2	y	desired
0	0	$f(-30) \approx 0$	0
0	1	$f(-10) \approx 0$	0
1	0	$f(-10) \approx 0$	0
1	1	$f(10) \approx 1$	1

$x_1 = 0, x_2 = 0.$

$$(w_1x_1 + w_2x_2) - (w_0 \times 1)$$

$$((20 \times 0) + (20 \times 0)) + (-30 \times 1)$$

$$(0 + 0) + (-30) = -30$$

developed by
Frank Rosenblatt.

- Perceptron Algorithm. (draws a lines by correct weights)
  - Given training patterns and computes output.
  - Connection weights are modified such that
    - desired output (d)
    - predicted output (y)

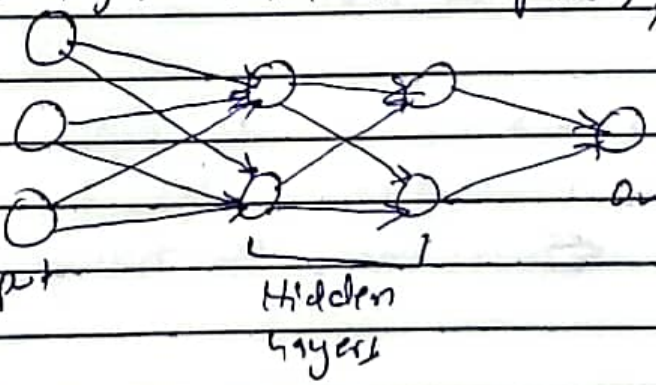
$$W_i(t+1) = W_i(t) + \eta (d-y) x_i$$

- $t+1$ → iteration number
- $(0 < \eta < 1.0)$ → step size or learning rate.

Steps:-
1) Initialize weights & threshold with small random values
2) Training pattern x communicates and output y is computed
3) Update weights W_i
4) Back to step 2

- Multilayer Perceptrons. (More hidden layers)
  - More layers a network comprises, higher-level features are learned.

extracts higher-level features.



- Feature detection →
  - Neuron are trained to detect specific features.
  - Every layer has its own features.

Neural Networks ⇒ Strengths
- works good with data having outliers.
- good accuracy rates.
- Used for both supervised and unsupervised.

- Back Propagation OR Delta learning Algo. →
  - How neural network learns from its mistakes.
  - Output layer ka error calculate kiya jata hy. Then this error, propagate reverse layer by layer so har weight ka galti ka andaza hoo.
  - Use gradient descent to minimize error.

Steps →
1. All weights randomly assigned.
2. labelled training dataset in.
3. For every input, output produced is compared with expected output.
4. Error is propagated back to previous layers.
5. Each layer wajib weights nikalti hy.
- Repeat step 4 to 5. till 1st hidden layer reached
- Update all weights

Issues →
- slow
- poor local optimum.
- needs alot of data.

Neural Networks ⇒ Weakness
- lack ability to explain how it is done.
- Sometimes over fitting.