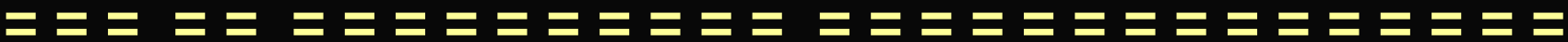
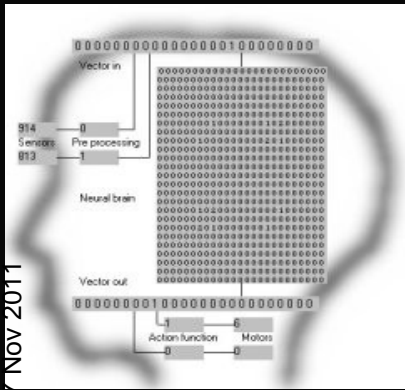


Nov 2011

Nature Precedings | doi:10.1038/npre.2011.6623.1 | Posted



Artificial Neural Network (ANN)



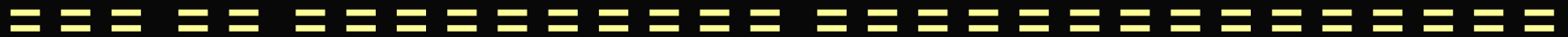
Smrita Singh

All India Institute Of Medical Sciences

ANNS

- Information processing paradigm that is inspired by the way biological nervous systems, such as the brain process information.
- Key element ----- Novel structure
- Composed of large number of highly interconnected processing elements (neurones) working in unison to solve specific problems.
- Configured for a specific application, (eg.... Pattern recognition or data classification through a learning process.)
- Learning in biological system involves adjustments to the synaptic connections that exist between the neurones.

Historical Background



- NNS Recent development.
- Initial period of enthusiasm Frustration and disrepute.
- Minsky and papertPublished a book in 1969.
- First artificial neuronproduced in 1943 (Warren McCulloch & Walter Pits).



Why Use Neural Network?



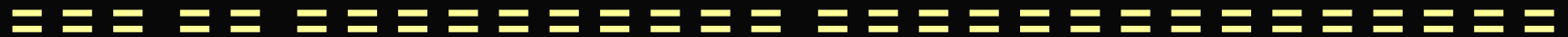
- To extract patterns and detect trends Complex to noticed by either humans or other computer technique.

Features

- Adaptive learning
- Self Organization
- Real Time Operation
- Fault Tolerance via Redundant Information Coding



Neural Network versus Von Neumann



- Trained by adjusting connection strengths thresholds & structure.
- Parallel & asynchronous
- Self organization during learning.
- Recalling by generalization
- Cycle time governs processor speed and occurs in milliseconds.

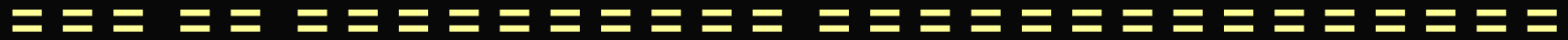
- Programmed with instructions (if then analogic)

Sequential & synchronous

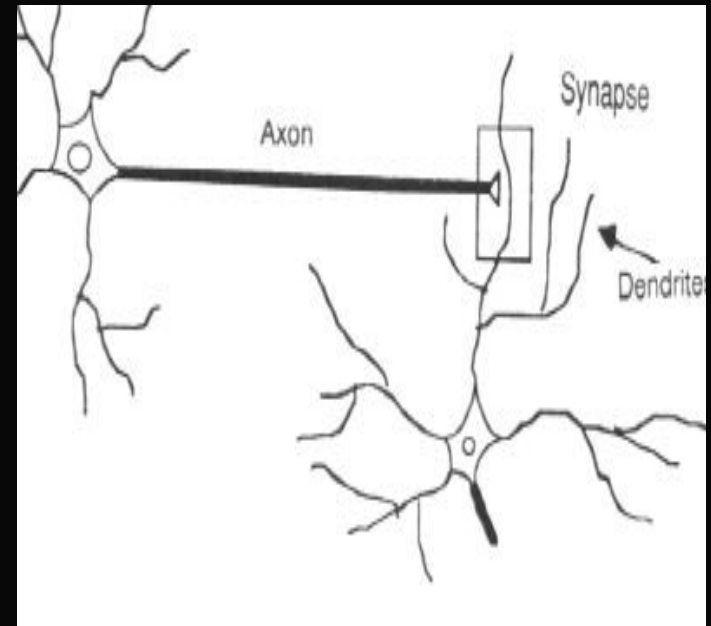
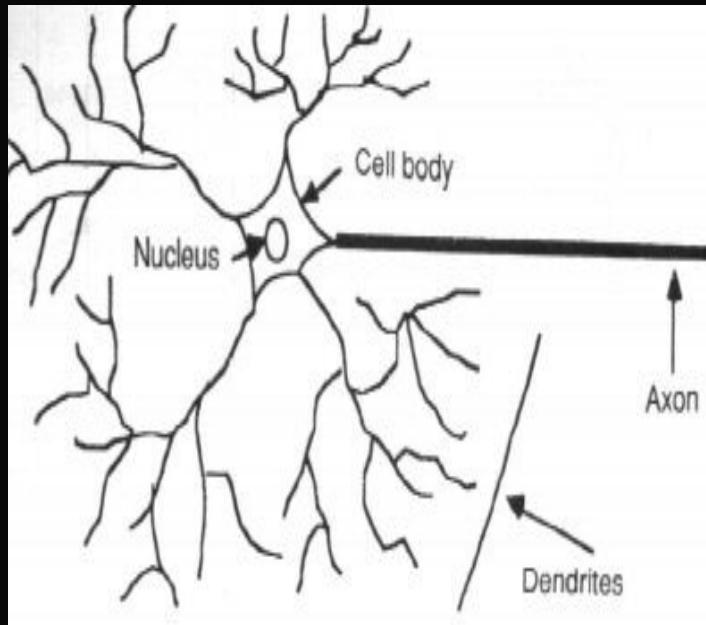
- Software dependent.
- Recalling by memorization.
- Cycle time corresponds to processing one step of a program and occurs in nanoseconds.



Humans and Artificial Neurons – Investigating the similarity



How the Human Brain Learns?

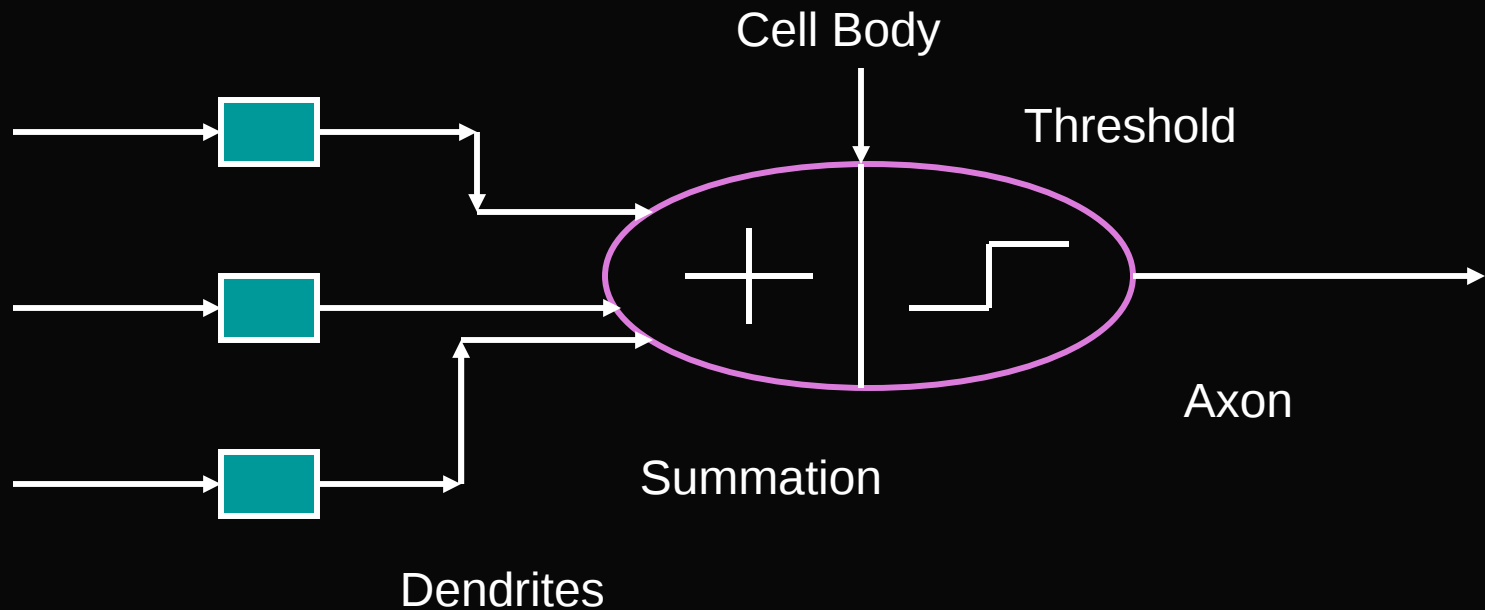


Learning occurs by changing the effectiveness of the synapses
(Influence of one neuron on another changes)



From Human Neurones to Artificial Neurones

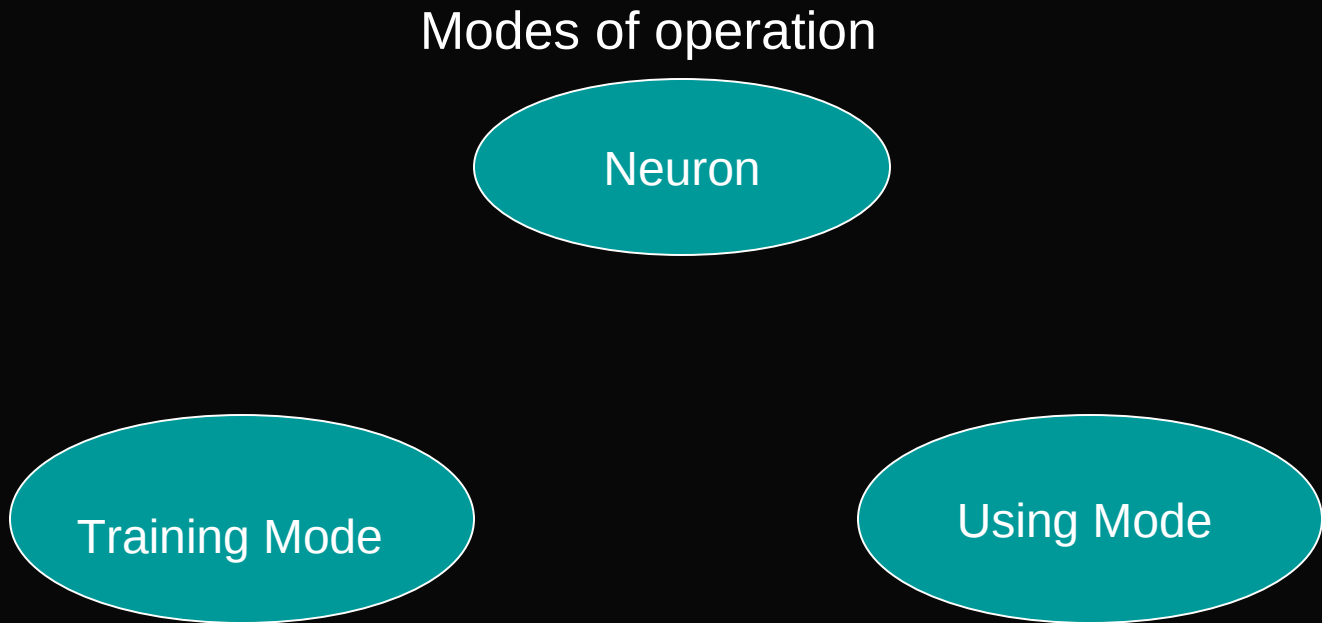
- Deduce the essential features of neurones and their interconnections.
- Program a computer to simulate features.



An Engineering Approach (A Simple Neuron)



- Device with many inputs and one output.



Training Mode



Neuron Trained
Fire/N

For Particular input patterns

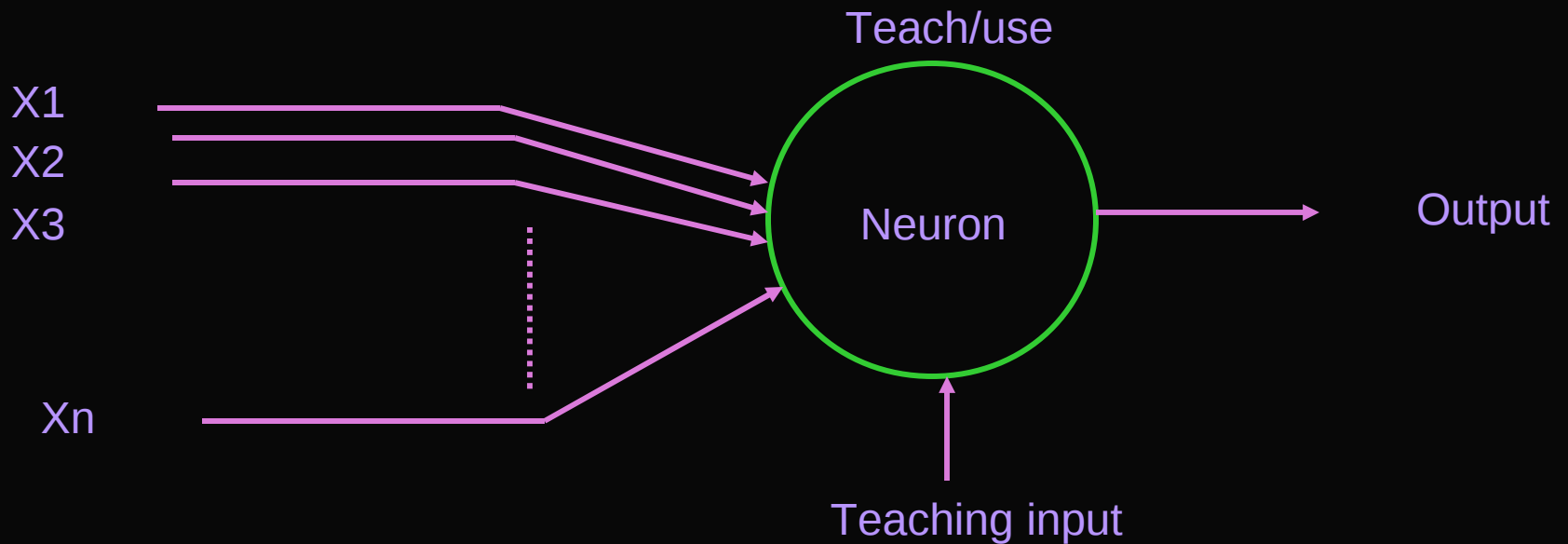
Using Mode



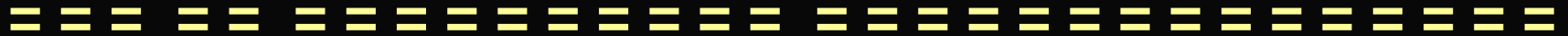
Neuron Taught input
pattern Fire/N



If the Input pattern doesn't belong in the taught list of input patterns,
Firing rule Used to determine (F/N)



Firing Rules



- A firing rule determines how one calculates whether a neuron should fire for any input pattern.
- Relates to all input patterns, not only the ones on which the node was trained.
- A firing rule can be implemented by using Hamming Distance Technique.



Hamming Distance Technique



➤ A 3 – input Neuron taught to output 1 when the input

X1 111 or 101

X2 111 or 101

X3 111 or 101 &

To output 0 when the input

X1 000 or 001

X2 000 or 001

X3 000 or 001



Truth Table



Probability & Possibility

X1		0	0	0	0	1	1	1	1
X2		0	0	1	1	0	0	1	1
X3		0	1	0	1	0	1	0	1
Out		0	0	0/1	0/1	0/1	1	0/1	1



Generalization of the Neuron



Applying the HDT (Nearest Pattern) (111,101---1 & 000, 001----0)

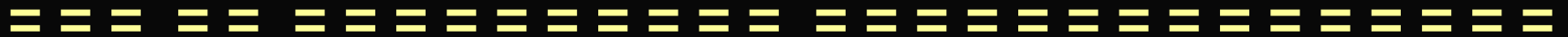
X1		0	0	0	0	1	1	1	1
X2		0	0	1	1	0	0	1	1
X3		0	1	0	1	0	1	0	1
Out		0	0	0/1	0/1	0/1	1	0/1	1

X1		0	0	0	0	1	1	1	1
X2		0	0	1	1	0	0	1	1
X3		0	1	0	1	0	1	0	1
Out		0	0	0	0/1	0/1	1	1	1

010---1E, 001---2E, 101---3E, (If --- tie ---- undefined state)



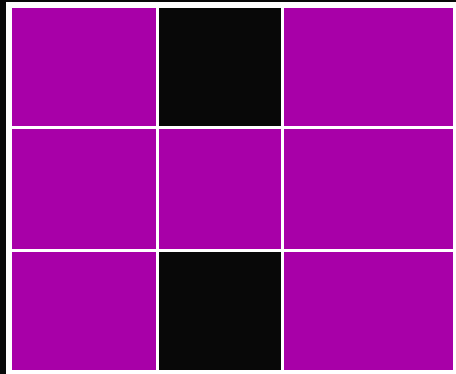
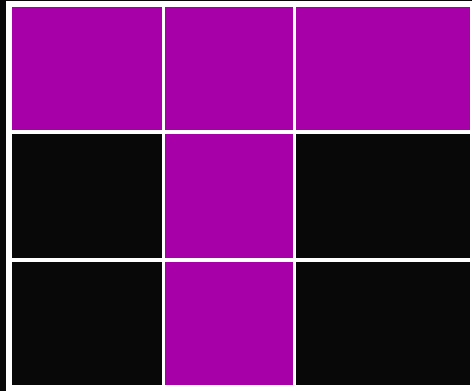
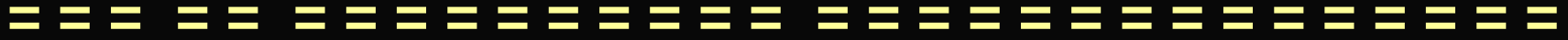
Pattern Recognition



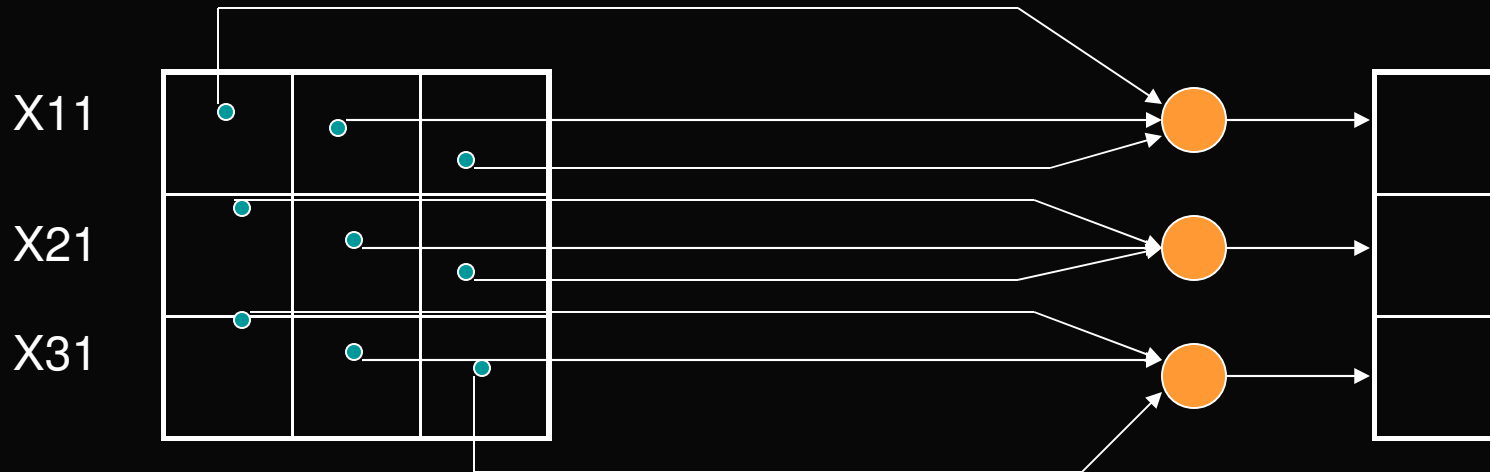
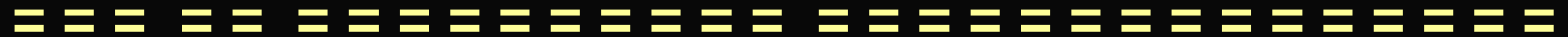
- Pattern recognition ---- Implemented by using feed forward modeltech..
- Neural network identifies the input pattern and tries to output the associated output pattern.
- The power of neural network ----- interesting when a pattern has no output associated with input pattern.
- Gives output that corresponds to a taught input pattern.
- The output pattern ---- least different from the given pattern.



The Pattern "T" & "H"



Generalization



X11		0	0	0	0	1	1	1	1
X12		0	0	1	1	0	0	1	1
X13		0	1	0	1	0	1	0	1
Out		0	0	1	1	0	0	1	1



Pink ---- 0, Gray ---- 1

Generalization Contd.....

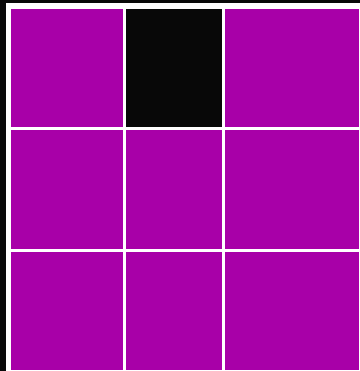
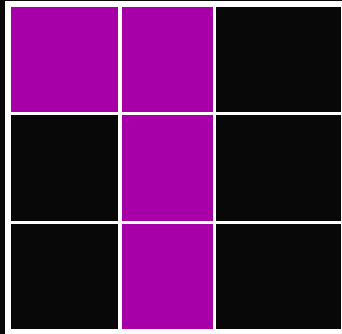
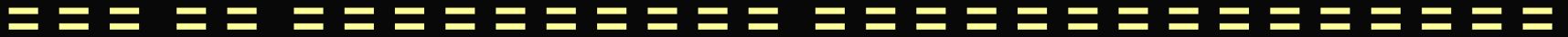


X21		0	0	0	0	1	1	1	1
X22		0	0	1	1	0	0	1	1
X23		0	1	0	1	0	1	0	1
Out		0	0/1	1	0/1	0/1	0	0/1	0

X31		0	0	0	0	1	1	1	1
X32		0	0	1	1	0	0	1	1
X33		0	1	0	1	0	1	0	1
Out		1	0	1	1	0	0	1	0



Generalization Contd.....



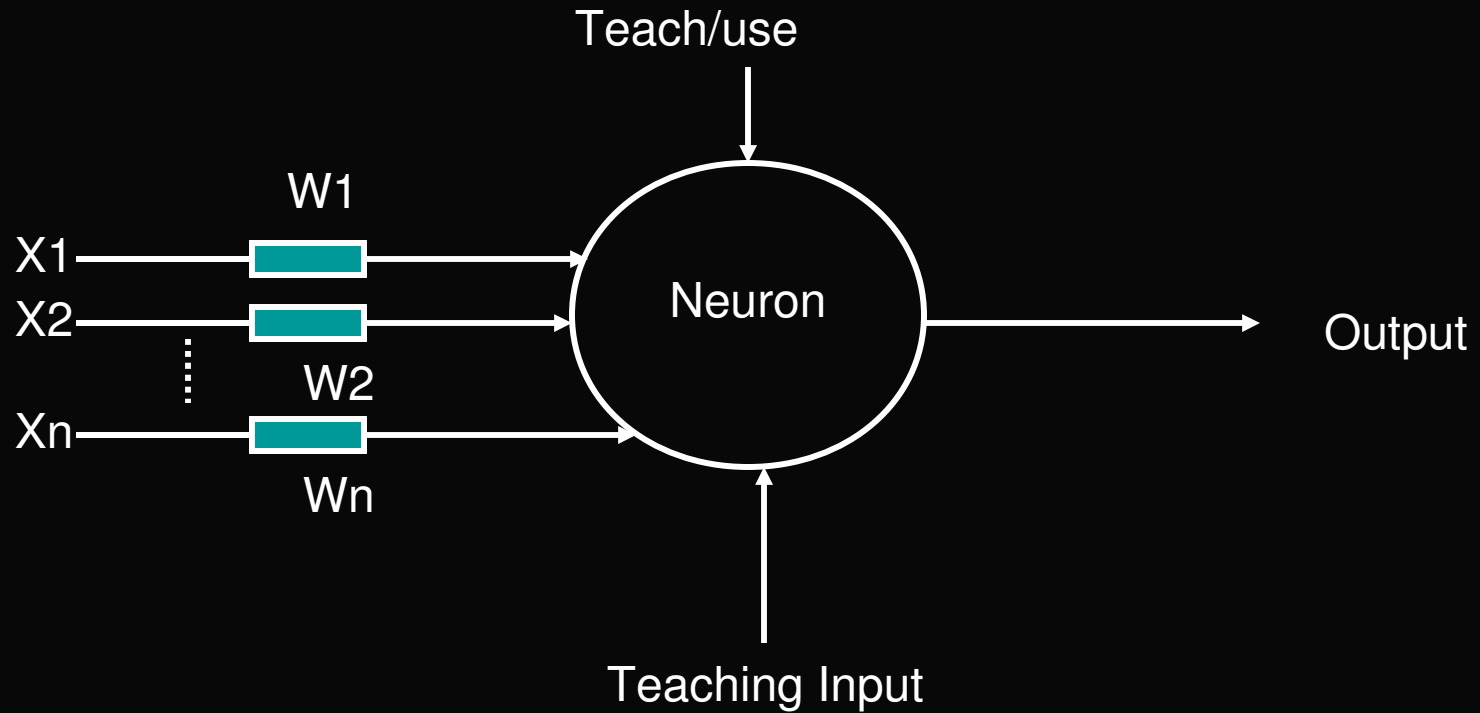
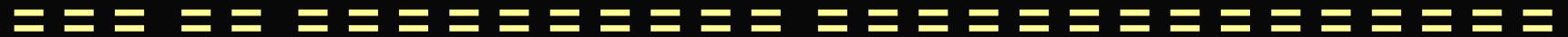
Mc Culloch & Pitts Model (CN)



- Inputs are weighted, the effect that each input has at decision making is dependent on the weight of the particular input.
- Weighted inputs Wt of an input (N),* Input.
- Weighted inputs Added
- The weighted inputs > Threshold value F/ NF
- Very flexible
- The MCP neuron Adapt FPS..... By Changing its weight and /or threshold
- Various Algorithms exist



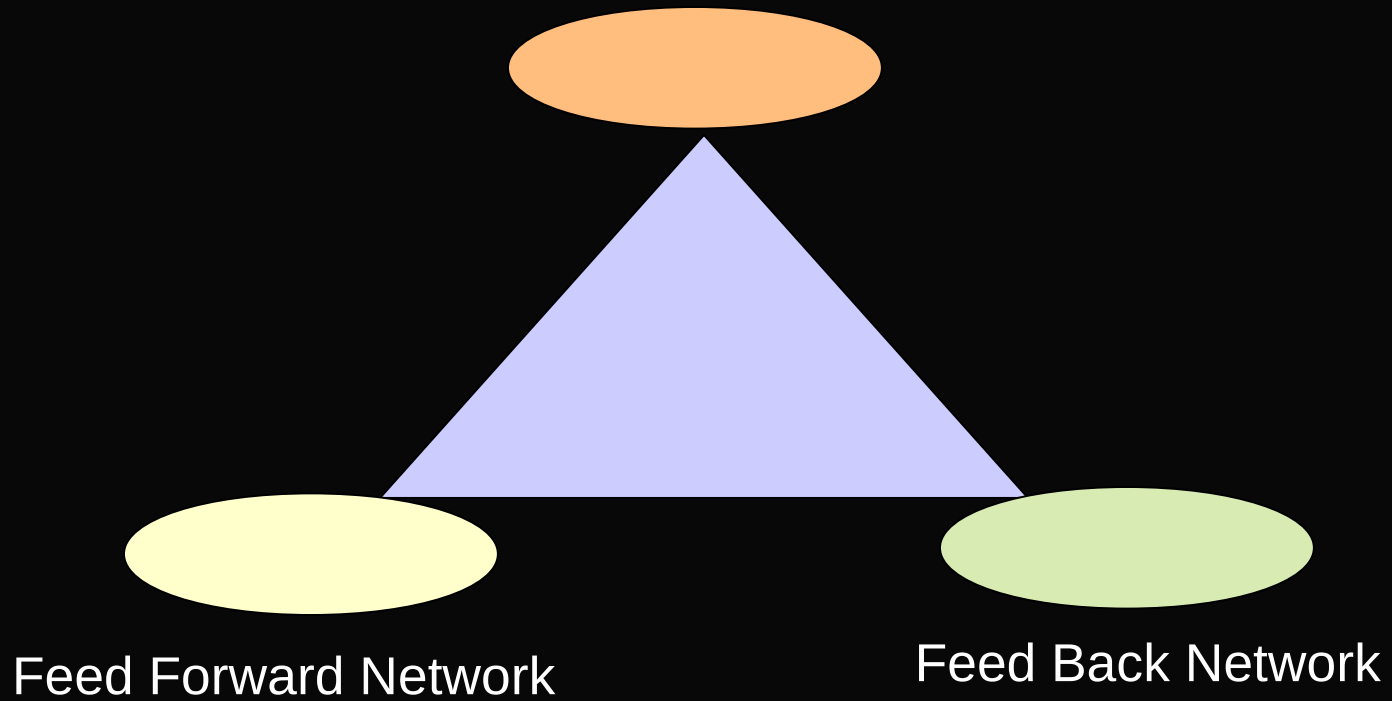
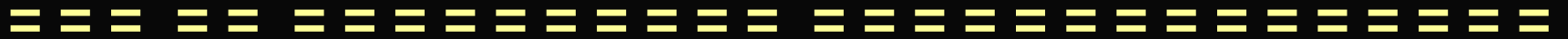
Mc Culloch & Pitts Model (CN)



$$X1W1 + X2W2 + X3W3 + X4W4 + \dots > T$$



Architecture of Neural Networks



Feed- Forward Network



- Allows signals to travel only one way
- From Input ----- Output
- No feedback (loops)
- Extensively used in pattern recognition
- Referred as bottom - up or top – down

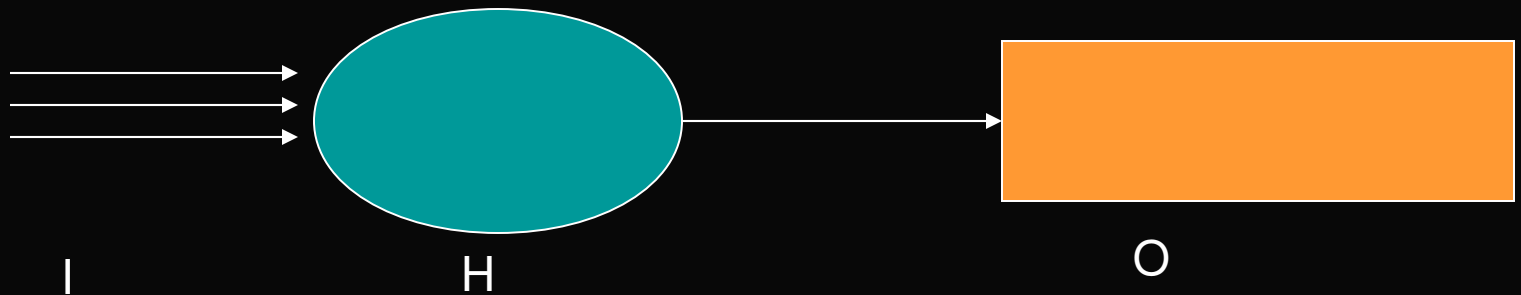
Feed Back Network

- Allows signals to travel in both directions
- Loops
- Dynamic ; state changes continuously until they reach an equilibrium point

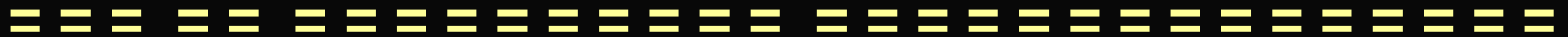


Network Layers (SLO)

- 3 layers.
- Input units Raw information fed into the network
- Activity of each hidden unit Determined by the activities of the input units and the weights on the connections between the input and the hidden units.
- Behaviour of the output units depends on the activity of the hidden units and the weights between hidden and output units



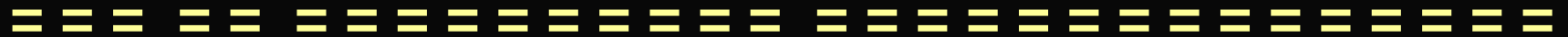
MLO/ MLN (Perceptrons)



- 1960's Frank Rosenblatt Coined the term
- The perceptron (neuron with weighted inputs) & additional, fixed, pre - processing
- Mimic the basic idea behind the mammalian visual system
- Untill 80's not realized that the appropriate training, multilevel perceptrons can do these operations (Determining the parity of a shape & whether shape is connected or not)



Memorization of patterns (Paradigm)



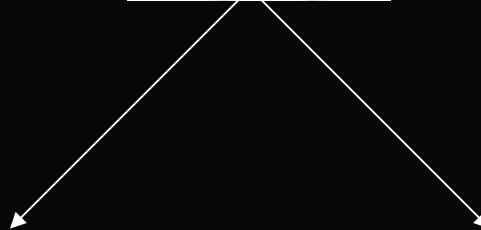
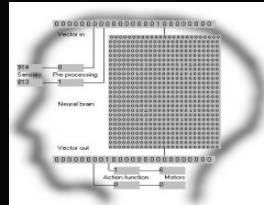
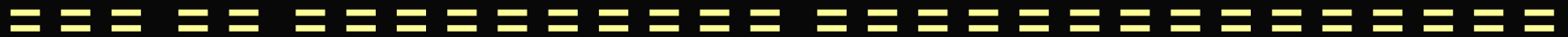
- Associative Mapping : Relationship among patterns
- Regularity Detection: Respond to a particular properties of the input (FD & KR)

Two mechanisms of associative mapping

- Auto association
- Hetero – association
- Related to two recall mechanism
- Nearest – neighbour Recall
- Interpolative Recall



Categories of Neural Networks



Fixed Networks

$$dW/dt = 0$$

Weight fixed according to the problem to solve (prior)

Adaptive Networks

$$dW/dt \neq 0$$

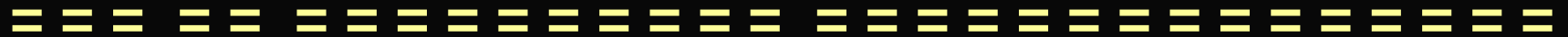
Learning Methods ---
Supervised & unsupervised



Learning Process

- **Supervised learning** : Incorporates an external teacher, so that each output unit is told what its desired response to input signals ought to be.
- Global information requires.
- Error correction learning, Reinforcement learning & stochastic learning.
- Error convergence
- **Unsupervised learning** : No external Teacher. Based upon local information
- Self organization

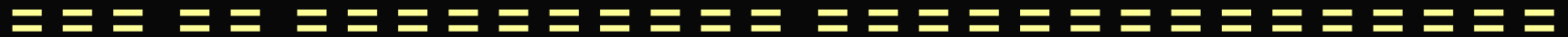
Transfer Functions



- Input – output functions.... Behaviour of ANN
- 3 Categories of function
- Linear (Ramp) Output activity proportional to the total weighted output
- Threshold units Total input is greater than or less than to the threshold value
- Sigmoid units Output varies continuously but not linearly as the input changes



Application of Neural Network



- Speech Recognition & Synthesis
- Image Processing & Coding
- Pattern Recognition & Classification
- Power Load Forecasting
- Interpretation & prediction of Financial trends for Stock market
- Processing Modelling, Monitoring & Control
- Optimization
- Vibration control Problem



Thank You