

Department of Electrical and Electronics Engineering

15EE661 – Artificial Neural Network and Fuzzy Logic (VI Semester - Open Elective)

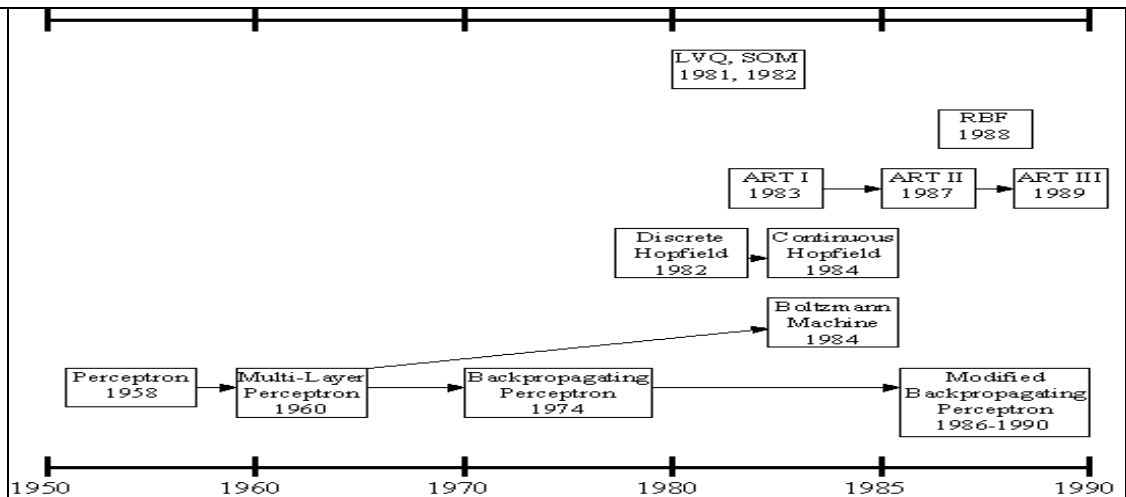
Academic year 2018-19

Question and Solution - IAT-I

		Marks	OBE	
			CO	RBT
1(a)	Compare Biological Neural Network with Artificial Neural Network.	[05]	CO1	L2
1(b)	Illustrate the following terms related to ANN. i) Weight ii) Bias iii) Threshold.	[05]	CO1	L3
2	Discuss about the evolution of Neural network models and learning algorithms.	[10]	CO1	L2
3	Explain in detail about McCulloch Pitts Neural Network with relevant architecture and algorithm.	[10]	CO2	L3
4(a)	Illustrate the following terms related to ANN. i) learning rate ii) Momentum factor iii) Vigilance parameter	[10]	CO1	L3
4(b)	Explain how an artificial neural network works?		CO2	L3
5	Explain different types of activation functions of artificial neural network.	[10]	CO2	L3
6	Illustrate the network architecture and learning procedure of Rosenblatt's Perceptron Model with suitable diagram.	[10]	CO2	L3
7	Illustrate the model structure with learning algorithm of ADALINE and MADALINE models.	[10]	CO2	L3

1(a)	Compare Biological Neural Network with Artificial Neural Network.		
Ans		Biological NN	Artificial NN
	Speed	Few ms.	Few nano sec. massive el processing
	Size and complexity	10 ¹¹ neurons & 10 ¹⁵ interconnections	Depends on designer
	Storage capacity	Stores information in its interconnection or in synapse. No Loss of memory	Contiguous memory locations loss of memory may happen sometimes.
	Tolerance	Has fault tolerance	No fault tolerance Inf gets disrupted when interconnections are disconnected

	Control mechanism	Complicated chemicals in neuron	involves biological	Simpler in ANN
1(b)	Describe the following terms related to ANN. i) Weight ii) Bias iii) Threshold.			
Ans	<p>Weight:</p> <ul style="list-style-type: none"> - Each neuron is connected to every other neuron by means of directed links - Links are associated with weights - Weights contain information about the input signal and is represented as a matrix <p>Weight matrix also called <u>connection matrix</u></p> <p>Bias:</p> <ul style="list-style-type: none"> - Bias is like another weight. Its included by adding a component $x_0=1$ to the input vector X. - $X=(1, X_1, X_2, \dots, X_i, \dots, X_n)$ - Bias is of two types - Positive bias: increase the net input - Negative bias: decrease the net input <p>Threshold:</p> <ul style="list-style-type: none"> - Set value based upon which the final output of the network may be calculated - Used in activation function - The activation function using threshold can be defined as $f(net) = \begin{cases} 1 & \text{if } net \geq \theta \\ -1 & \text{if } net < \theta \end{cases}$			
2	Discuss about the evolution of Neural network models and learning algorithms.			
Ans	<ul style="list-style-type: none"> • History of the ANNs stems from the 1940s, the decade of the first electronic computer. • However, the first important step took place in 1957 when Rosenblatt introduced the first concrete neural model, the perceptron. Rosenblatt also took part in constructing the first successful neurocomputer, the Mark I Perceptron. After this, the development of ANNs has proceeded as described in <i>Figure</i>. 			



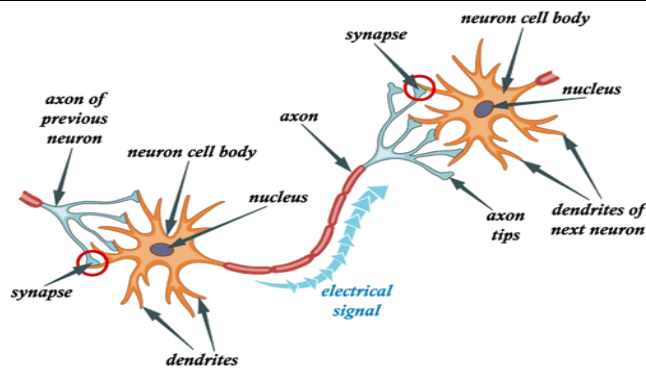
- Rosenblatt's original perceptron model contained only one layer. From this, a multi-layered model was derived in 1960. At first, the use of the multi-layer perceptron (MLP) was complicated by the lack of an appropriate learning algorithm.
- In 1974, Werbos came to introduce a so-called backpropagation algorithm for the three-layered perceptron network.
- in 1986, The application area of the MLP networks remained rather limited until the breakthrough when a general back propagation algorithm for a multi-layered perceptron was introduced by Rumelhart and McClelland.
- in 1982, Hopfield brought out his idea of a neural network. Unlike the neurons in MLP, the Hopfield network consists of only one layer whose neurons are fully connected with each other.
- Since then, new versions of the Hopfield network have been developed. The Boltzmann machine has been influenced by both the Hopfield network and the MLP.
- in 1988, Radial Basis Function (RBF) networks were first introduced by Broomhead & Lowe. Although the basic idea of RBF was developed 30 years ago under the name method of potential function, the work by Broomhead & Lowe opened a new frontier in the neural network community.
- in 1982, A totally unique kind of network model is the Self-Organizing Map (SOM) introduced by Kohonen. SOM is a certain kind of topological map which organizes itself based on the input patterns that it is trained with. The SOM originated from the LVQ (Learning Vector Quantization) network the underlying idea of which was also Kohonen's in 1972.

3 Explain in detail about McCulloch Pitts Neural Network with relevant architecture and algorithm.

Ans **McCulloch Pitts Neural Network:**

- Allows binary 0,1 states only

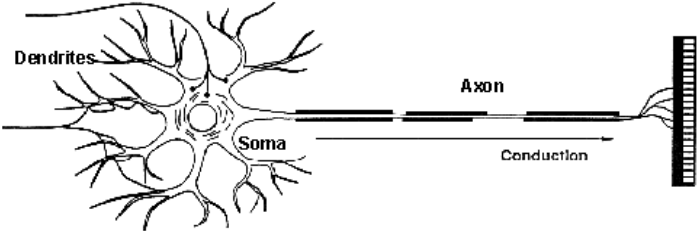
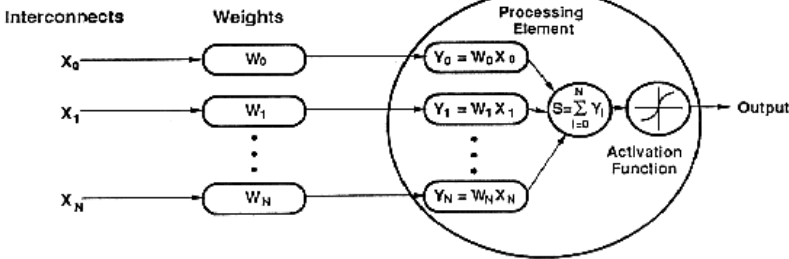
	<ul style="list-style-type: none"> - Operates under a discrete-time assumption - Weights and the neurons' thresholds are fixed in the model and no interaction among network neurons - Just a primitive model $o^{k+1} = \begin{cases} 1 & \text{if } \sum_{i=1}^n w_i x_i^k \geq T \\ 0 & \text{if } \sum_{i=1}^n w_i x_i^k < T \end{cases}$ <p>(a) $w_i = \pm 1, i = 1, 2, \dots, n$</p> <p>(b) (NOR)</p> <p>(c) (NAND)</p> <p>(d) (MEMORY CELL)</p>
<p>4(a)</p>	<p>Illustrate the following terms related to ANN. i) learning rate ii) Momentum factor iii) Vigilance parameter</p>
<p>Ans</p>	<p>Learning rate:</p> <ul style="list-style-type: none"> - Denoted by α. - Used to control the amount of weight adjustment at each step of training - Learning rate ranging from 0 to 1 determines the rate of learning in each time step <p>Momentum factor:</p> <ul style="list-style-type: none"> - used for convergence when momentum factor is added to weight updation process. <p>Vigilance parameter:</p> <ul style="list-style-type: none"> - Denoted by ρ - Used to control the degree of similarity required for patterns to be assigned to the same cluster
<p>4(b)</p>	<p>Explain how an artificial neural network works?</p>
<p>Ans</p>	<ul style="list-style-type: none"> - An artificial neural network consists of a pool of simple processing units which communicate by sending signals to each other over a large number of weighted connections.



- NN are constructed and implemented to model the human brain.
- Performs various tasks such as pattern-matching, classification, optimization function, approximation, vector quantization and data clustering.
- These tasks are difficult for traditional computers

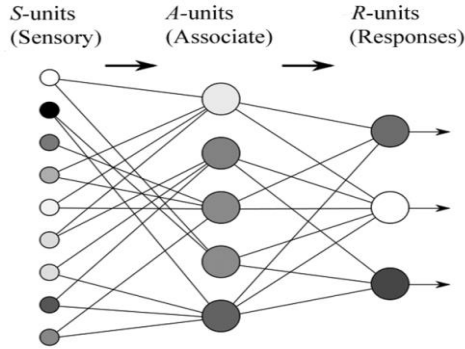
Working of NN:

- ANN possess a large number of processing elements called nodes/neurons which operate in parallel.
- Neurons are connected with others by connection link.
- Each link is associated with weights which contain information about the input signal.
- Each neuron has an internal state of its own which is a function of the inputs that neuron receives- Activation level
- A neuron is connected to other neurons through about *10,000 synapses*
- A neuron receives input from other neurons. Inputs are combined.
- Once input exceeds a critical level, the neuron discharges a spike - an electrical pulse that travels from the body, down the axon, to the next neuron(s)
- The axon endings almost touch the dendrites or cell body of the next neuron.
- Transmission of an electrical signal from one neuron to the next is effected by neurotransmitters.
- Neurotransmitters are chemicals which are released from the first neuron and which bind to the Second.
- This link is called a synapse. The strength of the signal that reaches the next neuron depends on factors such as the amount of neurotransmitter available.
- It is an imitation of human brain.

	<p>Biological Neuron</p>  <p>Artificial Neuron</p> 
5	Explain different types of activation functions of artificial neural network.
Ans	<ul style="list-style-type: none"> • Used to calculate the output response of a neuron. • Sum of the weighted input signal is applied with an activation to obtain the response. • Activation functions can be linear or non linear • General Types <ul style="list-style-type: none"> • Identity function • Single/binary step function • Discrete/continuous sigmoidal function. • Bipolar binary and unipolar binary are called as hard limiting activation functions used in discrete neuron model • Unipolar continuous and bipolar continuous are called soft limiting activation functions are called <u>sigmoidal</u> characteristics. • Commonly used activation functions: <ul style="list-style-type: none"> • Commonly used activation functions, • Identity function • Step function • Binary Step function • Bipolar Step function • Signum function • Binary signum function • Bipolar signum function • Ramp function
6	Illustrate the network architecture and learning procedure of Rosenblatt's Perceptron Model with suitable diagram.

Ans

- Inventor of the Perceptron (the first historically known neural network) and the error-correction learning rule.
- F. Rosenblatt first used his perceptron to recognize text (black and white English typed letters)



- **Perceptron** – It is the computational model of retina of the eye.
- *S-units are just sensors (like eye retina)*
- *R-units are just responsible for reproduction of the information in terms suitable for its understanding*
- *A-units are the threshold neurons, which process the information*
- Each A-unit is trained separately using a learning algorithm based on the error-correction learning rule.
- Weight updation is done by,
 - (For decreasing the output)
 - (For decreasing the output)
 - If α is constant, learning algorithm-Fixed increment Algorithm.

Drawback of Perceptron:

- By Minsky and Papert
- Observed the limitations of perceptron.
- Pointed out that it is applicable for a problems with linear separable solution space.
- Perceptron can not handle the task which are linearly separable.

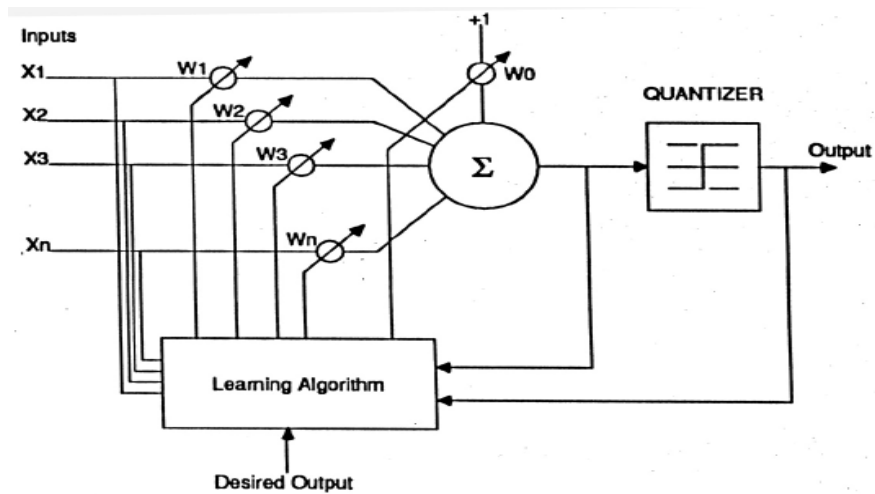
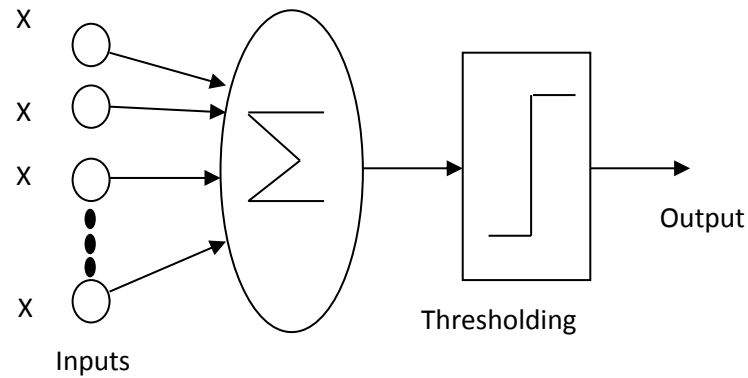
7

Illustrate the model structure with learning algorithm of ADALINE and MADALINE models.

Ans

Adaptive Linear Neural Element (ADALINE):

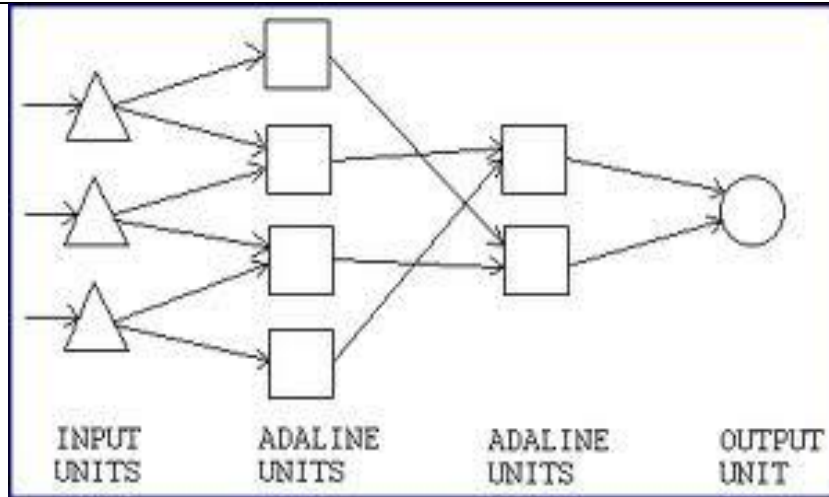
- Sometime referred as Adaptive Linear Neuron.
- Invented by Dr. Bernard Widrow in 1959.
- Adaline is a network with a single linear unit.
- Input – Binary / Bipolar / Real.
- Output – Bipolar (+1/-1).



- Like the perceptron, use a threshold logic device that performs a linear summation of inputs (Classify linearly separable patterns)
- Its weight parameters are adapted over time.
- The Adaline network is trained using the delta rule or Widrow-Hoff Learning rule.
- Initially random weights are assigned. The net input calculated is applied to a activation function that restores the output to +1 or -1.
- The Adaline model compares the actual output with the target output and with the bias and adjusts all the weights.

Multiple Adaptive Linear Neural Element (MADALINE):

- Otherwise referred as Multiple Adaptive Linear Neuron.
- It consists of many adalines in parallel with a single output unit whose value is based on certain selection rules.



- It uses the majority vote rule
- On using this rule, the output unit would have an answer either true or false.
- On the other hand, if AND rule is used, the output is true if and only if both the inputs are true and so on.
- The training process of madaline is similar to that of adaline.
- Both Adaline and Madaline comes under the supervised learning networks.
