

Subject-Soft Computing ,MCA-Vth Semester-2012

Max Marks -60

Section A

Note : Attempt all questions .All questions carry equal marks 10x2=20

- Associate the characteristics of Biological Neural Network with Artificial Neural Network .

Ans: Neural networks are inspired by our brains.The human brain has about 10^{11} neurons and 10^{14} synapses.A neuron consists of a soma (cell body), axons (sends signals), and dendrites (receives signals).A synapse connects an axon to a dendrite.Given a signal, a synapse might increase (excite) or decrease(inhibit) electrical potential. A neuron fires when its electrical potential reaches a threshold. Learning might occur by changes to synapses. Artificial Neural Networks. An (artificial) neural network consists of units, connections, and weights. Inputs and outputs are numeric. Significant difference between these two are as follow:

Biological Neural Network	Artificial Neural network
Soma	Unit
Axon ,Dendrite	Connection
Synapse	Weight
Potential	Weighted Sum
Threshold	Bias Weight
Signal	Activation

- Write equation of any four activation functions.

Ans: Following are the equation of activation functions

- Identity function: $f(x)=x$ for all x
- Sigmoidal function $f(x)=$
- Bipolar sigmoidal function $f(x) =$
- Step function $f(x) = \begin{cases} 1 & \text{if } x \geq \theta \\ 0 & \text{if } x < \theta \end{cases}$

1 if $x < \theta$

Where θ is threshold value

- Define bidirectional associative memory (BAM) and its type .

Ans:An associative memory network can store a set of patterns .When the associative memory is being presented with a key pattern ,it responds one of the second pattern. This is type of memory known as content addressable memory (CAM) .BAM was developed by kosko in 1998 .BAM

network perform forward and backward associative search for stored stimuli responses. BAM neural nets can respond to input from either layers .There exist two types of BAM : Discrete and continuous BAM.

- Explain Kohonen self –organizing map .

Ans: Our brain is dominated by the cerebral cortex, a very complex structure of billions of neurons and hundreds of billions of synapses. The cortex includes areas that are responsible for different human activities (motor, visual, auditory, etc.) and associated with different sensory inputs. One can say that each sensory input is mapped into a corresponding area of the cerebral cortex. The cortex is a self-organizing computational map in the human brain. Following are the features of KSOFM :

- The Kohonen model provides a topological mapping.
- It places a fixed number of input patterns from the input layer into a higher dimensional output or Kohonen layer.
- Training in the Kohonen network begins with the winner’s neighborhood of a fairly large size. Then, as training proceeds, the neighborhood size gradually decreases.
- Kohonen SOMs result from the synergy of three basic processes
 - Competition,
 - Cooperation,
 - Adaptation.

- Fuzzy set is an extension of crisp set-Explain.

Ans: traditional logic can deal only with two values 0 or 1 but real world problem is full of uncertainty which require multiple value in between 0 and 1 ,hence we need multi valued logic. Therefore traditional logic which is known as two valued logic is extended as multivalued logic popularly known as fuzzy logic.

- Fuzzy logic is the logic underlying approximate, rather than exact, modes of reasoning.
 - 0 or 1 in two-value system,
 - Multiple values in between 0 and 1 as multivalued logic .
- How the necessity and possibility measures obtained from belief and plausibility measures.

Ans: A fuzzy measure explains the imprecision or ambiguity in the assignment of an element a to two or more crisp sets. A fuzzy measure is defined by a function $g: P(X) \rightarrow [0, 1]$

Which assigns to each crisp subset of universe of discourse X a number in the unit interval $[0, 1]$, where $P(X)$ is power set of X . A fuzzy measure has to follow three different conditions.

If N , Π and B are necessity, possibility, plausibility and belief measures then following equations can be written :

$$N(A) = 1 - \Pi(A), \Pi(A) = 1 - N(A), \Pi(A) = 1 - B(A), B(A) = 1 - \Pi(A)$$

Where A is an element of power set $P(X)$

- What are the different parts of membership function .

Ans: There are various parts of fuzzy membership function known as core, support and boundary as explained below:

- State Charles Darwin theory of natural evolution.

Ans: Charles Darwin has formulated the fundamental principle of natural selection as the main evolutionary tool. He put forward his ideas without the knowledge of basic heredity principles. In the origin of species, Charles Darwin stated the theory of natural evolution. Over many generations, biological organisms evolve according to the principles of natural selection like survival of the fittest to reach some remarkable forms of accomplishment.

- What is search space in Genetic algorithm.

Ans: Through GA we need best solution from a set of possible solutions. The space of all feasible solutions is called search space. Each point in the search space represents one possible solution. Therefore each possible solution can be marked by its fitness value depending on the problem definition.

- What is encoding in Genetic Algorithm?

Ans: Encoding is a process of representing individual genes. The process can be performed using bits, numbers, trees, arrays, lists or any other objects. There are various encoding methods, these are:

- Binary encoding
- Value encoding
- Octal encoding

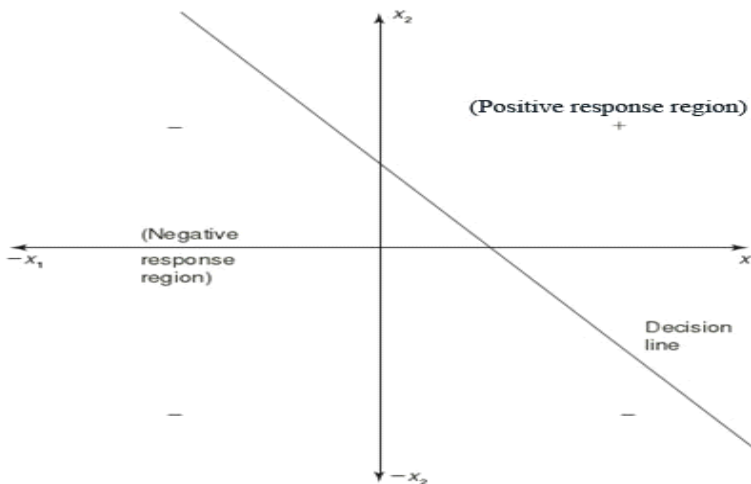
- Permutation encoding

Section –B

Note : Attempt any four questions. All questions carry equal marks. 4X10=40

- Explain linearly separable and linearly non separable problem with suitable example.

Ans: Linear separability is the concept wherein the separation of the input space into regions is based on whether the network response is positive or negative. Consider a network having positive response in the first quadrant and negative response in all other quadrants (AND function) with either binary or bipolar data, then the decision line is drawn separating the positive response region from the negative response region.



In the above example it is clear that logical AND problem is linearly separable problem on the other hand in case of non linearly separable problem a single line can not separate two different types of data (Say positive and negative). Logical XOR problem is non linearly separable problem as shown in the following figure in which two lines are required.

- (a) Prove that the derivation of hyperbolic tangent function $f(x)$ is $[1+f(x)] * [1-f(x)]$.

Ans : $f(x) = \tanh x$

$$F'(x) = \sec^2 hx = 1 - \tan^2 hx = (1 - \tanh x)(1 + \tanh x) = (1 + f(x))(1 - f(x))$$

(b) Design a Hebbian network (Hebb Net) to implement logical OR function. Train the network with bipolar input and target.

Ans: Donald Hebb stated in 1949 that in the brain, the learning is performed by the change in the synaptic gap. Hebb explained it:

“When an axon of cell A is near enough to excite cell B, and repeatedly or permanently takes place in firing it, some growth process or metabolic change takes place in one or both the cells such that A’s efficiency, as one of the cells firing B, is increased.”

A Hebb network for implementing logical AND function will have two neurons in input layer and one neuron in output layer. Architecture of Hebb network is shown below:

The training data for logical AND function in bipolar form is as below:

Input-1	Input-2	Target
1	1	1
1	-1	-1
-1	1	-1
-1	-1	-1

Note: By following learning algorithm of Hebb network one can obtain final weights after first iteration.

Say for example for first pattern [1 1] we can calculate new weights as follow:

$$W1(\text{new}) = w1(\text{old}) + xy = 0 + 1 \times 1 = 1 \text{ initially } w1 \text{ and } w2 = 0$$

$$\text{Similarly : } W2(\text{new}) = w2(\text{old}) + xy = 0 + 1 \times 1 = 1$$

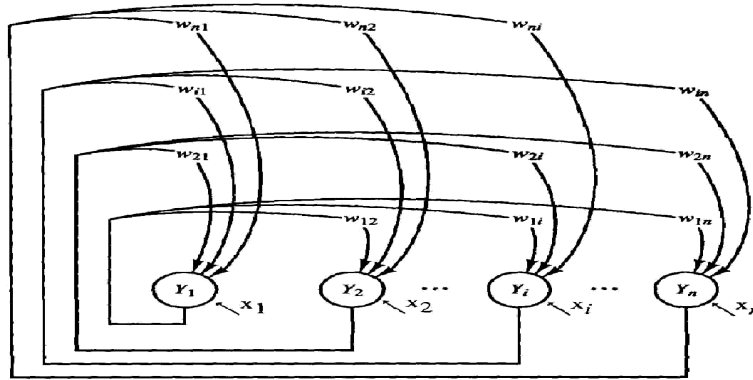
- (a) Discuss training algorithm of discrete Hopfield network.

Ans: The Hopfield network is an auto-associative fully interconnected single-layer feedback network. It is also a symmetrical weighted network. When this is operated in discrete time fashion it is called a Hopfield discrete network and its architecture as single layer feedback network can be called recurrent. The network takes two values input either binary or bipolar. The network has symmetrical weights with no self connections.

Architecture

- Single-layer (units serve as both input and output):

- nodes are threshold units (binary or bipolar).
- weights: fully connected, symmetric, and zero diagonal.



$$w_{ij} = w_{ji}$$

$$w_{ii} = 0$$

Training of Discrete Hopfield network : For storing a set of binary pattern $s(p)$, $p=1$ to p , the weight matrix is given as:

• **Weights:**

– To store patterns $s(p)$, $p=1, 2, \dots, P$

bipolar: $w_{ij} = \sum_p s_i(p) s_j(p) \quad i \neq j$

$$w_{ii} = 0$$

same as Hebbian rule (with zero diagonal)

binary: $w_{ij} = \sum_p (2s_i(p) - 1)(2s_j(p) - 1) \quad i \neq j$

$$w_{ii} = 0$$

converting $s(p)$ to bipolar when constructing W .

(b) What is the role of energy function in discrete Hopfield network. Proof mathematically.

Ans: Stability of Hopfield network can be defined with the help of energy function. Hopfield nets have a scalar value associated with each state of the network referred to as the "energy", E , of the network, where:

$$E = -\frac{1}{2} \sum_{i,j} w_{ij} s_i s_j + \sum_i \theta_i s_i$$

This value is called the "energy" because the definition ensures that when units are randomly chosen to update, the energy E will either lower in value or stay the same. Furthermore, under repeated updating the network will eventually converge to a state

which is a [local minimum](#) in the energy function (which is considered to be a [Lyapunov function](#)). Thus, if a state is a local minimum in the energy function, it is a stable state for the network. Note: Detail of energy function in two different cases should be explained.

- Consider the following two fuzzy sets in zadeh form

A= and B=

Perform the following operations over the above two fuzzy sets

- A (b) A (c) Compliment of A (d) Compliment of

Ans: (a) A =

- A =
- Compliment of =
- Compliment of A =

- Write short notes on Fuzzy relation with suitable numerical example.

Ans: A fuzzy relation R is a mapping from the Cartesian space $X \times Y$ to the interval $[0,1]$, where the strength of the mapping is expressed by the membership function of the relation $\mu_R(x,y)$

The “strength” of the relation between ordered pairs of the two universes is measured with a membership function expressing various “degree” of strength $[0,1]$

Let A be a fuzzy set on universe X, and B be a fuzzy set on universe Y, then $A \times B = R \subset X \times Y$

Where the fuzzy relation R has membership function

$$\mu_R(x,y) = \mu_{A \times B}(x,y) = \min(\mu_A(x,y), \mu_B(x,y))$$

The basic operation on fuzzy sets also apply on fuzzy relations. These are as follow:

- Union : $\mu_{AB}(x,y) = \max(\mu_A(x,y), \mu_B(x,y))$
- Intersection : $\mu_{A \cap B}(x,y) = \min(\mu_A(x,y), \mu_B(x,y))$

$$\text{Compliment } \mu(x,y) = 1 - \mu_R(x,y)$$

- What do you understand by optimization.? Explain genetic algorithm in this context.

Ans: Optimization is a process of selecting best elements from a set of available alternatives. In the simplest case, an [optimization problem](#) consists of [maximizing or minimizing](#) a [real function](#) by systematically choosing [input](#) values from within an allowed set and computing the [value](#) of

the function.. More generally, optimization includes finding "best available" values of some objective function given a defined [domain](#), including a variety of different types of objective functions and different types of domains. In many of the real world problem ,optimization is requires ,these includes engineering ,science, control system ,finance etc.

Genetic algorithm is widely acceptable for optimization problem.

Note: An example related to optimization through GA must be explained in detail.

- How crossover is performed ?Explain various crossover techniques of genetic algorithm.

Ans: Crossover is the process of taking two parent solutions and producing from them a child.

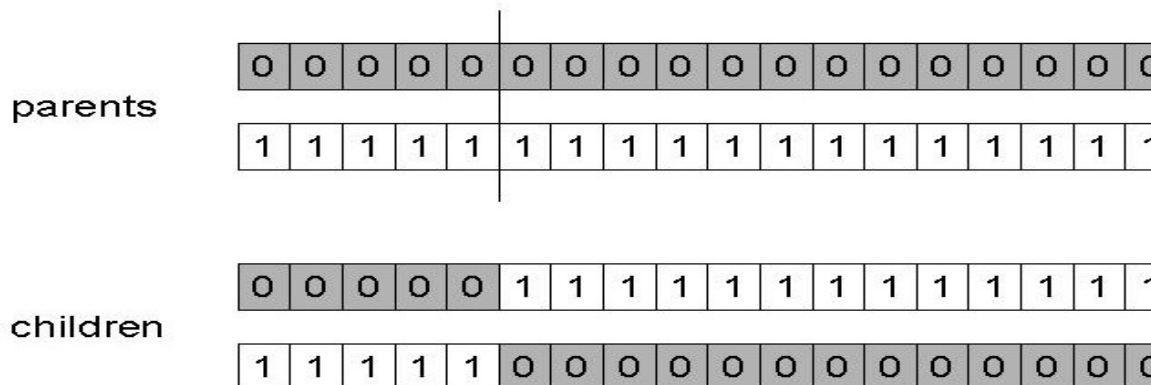
Crossover proceeds in three different steps.

- The reproduction operator selects at random a pair of two individual strings for the mating
- A cross site is selected at random along the string length
- Finally the position values are swapped between the two strings following the cross site

There are many crossover techniques as follows :

- **Single point crossover**

- Choose a random point on the two parecnts.
- Split parents at this crossover point.
- Create children by exchanging tails.



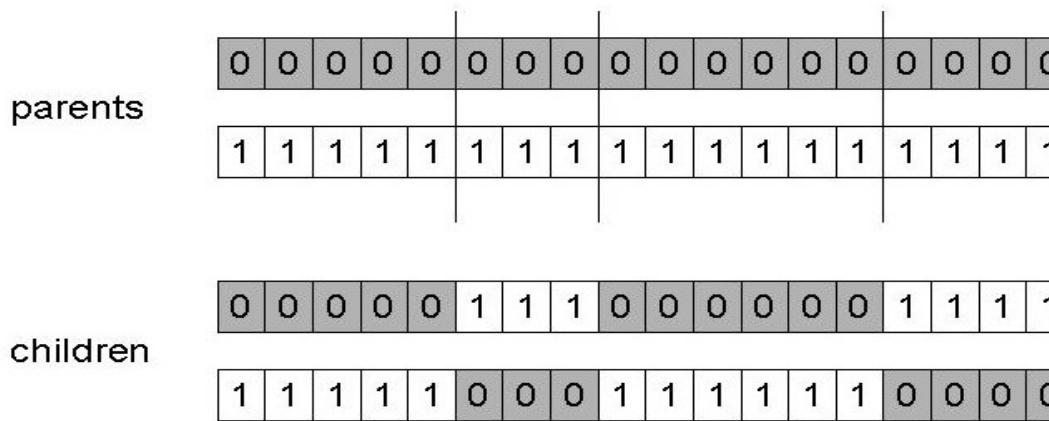
- **N-Point crossover**

Choose n random crossover points.

Split along those points.

Glue parts, alternating between parents.

Generalization of 1 point.



- **Uniform crossover**

Generate uniformly random number.

$$X1 = 0110001010$$

$$X2 = 1100000111$$

Uniformly generated = 1000001000

As a result, the new population becomes,

$$X1 = 1110000010$$

$$X2 = 0100001111$$