

(Time: 3 Hrs)

Marks: 80

N.B. : 1. Question no. 1 is **compulsory**.

2. Solve any **Three** questions out of remaining **Five** questions.

Qu-1 Attempt any **FOUR** of the following.

- a) **Demonstrate/outline** the working of Roulette-wheel selection. **5**
- b) A single-layer neural network has the weights $w = [0.2 \ 0.5 \ 0.66 \ 0.45]$ with bias $b=0.3$. It is given an input of $I = [0.5 \ 0.8 \ 0.1 \ 0.36]$. **5**
Find/estimate the output if the sigmoidal activation function is used (slope = 0.3)
- c) **Demonstrate/Outline** the excluded middle axioms, extended for fuzzy sets. **5**
- d) How do genetic Algorithms differ from conventional optimization algorithms? **5**
- e) Let us consider the discrete fuzzy set $A = \left\{ \frac{1}{a} + \frac{0.9}{b} + \frac{0.6}{c} + \frac{0.3}{d} + \frac{0.01}{e} + \frac{0}{f} \right\}$ using Zadeh's notation, defined on universe $X = \{a, b, c, d, e, f\}$. **5**
Compute/Infer λ cut for: a) $\lambda = 0.9$ b) $\lambda = 0.3$

Qu-2 a) Using Mamdani fuzzy model design a fuzzy logic controller to determine the wash time of a domestic washing machine. Assume that the inputs are dirt and grease on cloths. Use three descriptors for each input variables and five descriptors for the output variable. Derive a set of rules for control action and defuzzification. The design should be supported by figures wherever possible. Show/Defend that if the clothes are soiled to a larger degree the wash time will be more and vice-versa. **10**

b) Explain McCulloch Pitts neuron model with example. **10**

Qu-3 a) Determine the weights after one iteration for Hebbian learning of a single neuron network starting with initial weights $w = [1 \ -1]$. The inputs are $X_1 = [1 \ -2]$, $X_2 = [2 \ 3]$, $X_3 = [1, -1]$ and learning rate $c=1$. **10**
a) Use Bipolar Binary activation function.
b) Use Bipolar continuous activation function.

b) What are Neuro-Fuzzy Systems? Explain the steps in Neuro-Fuzzy Hybrid System. **10**

Qu-4 a) What is Linear Separability? Explain with example why single layer perceptron is not capable of solving Linearly Inseparable problems. **10**

b) Using the binary input/output row matrix shown in table-1 train a hetero-associative network to store the input row vectors $s = \{s_1, s_2, s_3, s_4\}$ to the output row vector $t = \{t_1, t_2\}$. Obtain/predict the final weight matrix **10**

Table-1: Input row vectors $\{s_1, s_2, s_3, s_4\}$ and output row vector $\{t_1, t_2\}$.

| | s1 | s2 | s3 | s4 | t1 | t2 |
|-----------------|----|----|----|----|----|----|
| 1 st | 1 | 0 | 0 | 0 | 1 | 0 |
| 2 nd | 1 | 1 | 0 | 0 | 1 | 0 |
| 3 rd | 0 | 0 | 0 | 1 | 0 | 1 |
| 4 th | 0 | 0 | 1 | 1 | 0 | 1 |

Qu-5

Consider a 2-2-2 three-layer network as shown in figure-1. Perform calculations (upto 4 decimal places) assuming back-propagation learning for one iteration on the input, and desired output patterns given in Table-2.

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a) Learning rate $\eta = 0.8$, Momentum $\alpha = 0.8$ and Sigmoidal activation function.

Table-2: Input-Output pattern.

| Pattern Index | Input | | Output/desired | |
|---------------|-------|------|----------------|-----|
| | X1 | X2 | O1 | O2 |
| 1 | 0.5 | -0.5 | 0.9 | 0.1 |

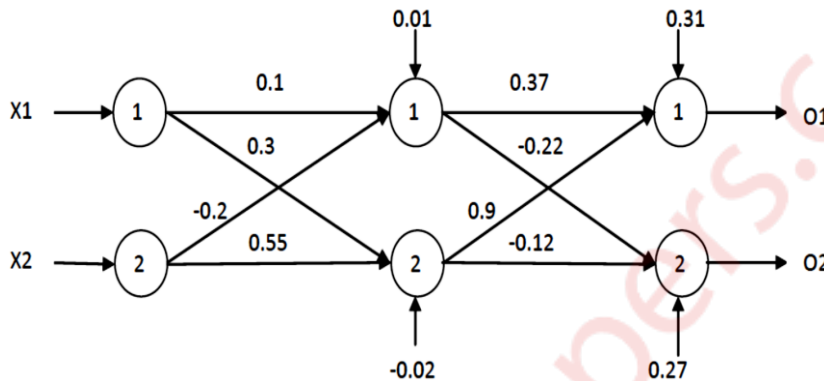


Figure-1: The MLP with initial weights

Qu-6

a) Describe Genetic Algorithms considering: Encoding, Selection, Crossover, Mutation, and Stopping Condition for Genetic Algorithms.

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b) Let R and S be two fuzzy relations defined as:

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$$R = \begin{matrix} & y1 & y2 & y3 \\ x1 & \begin{pmatrix} 0.0 & 0.2 & 0.8 \end{pmatrix} \\ x2 & \begin{pmatrix} 0.3 & 0.6 & 1.0 \end{pmatrix} \end{matrix} \quad S = \begin{matrix} & z1 & z2 & z3 \\ y1 & \begin{pmatrix} 0.3 & 0.7 & 1.0 \end{pmatrix} \\ y2 & \begin{pmatrix} 0.5 & 1.0 & 0.6 \end{pmatrix} \\ y3 & \begin{pmatrix} 1.0 & 0.2 & 0.0 \end{pmatrix} \end{matrix}$$

a) Compute/Infer the result of $R \circ S$ using max-min composition.

b) Compute/Infer the result of $R \cdot S$ using max-product composition.