M. E (ICE), 1st Year 2nd Semester, End-Semester Examination 2013

Subject: Soft Computing Techniques (ICE-1004)

Full Marks: 70 **Duration: 3 Hours**

Answer any five questions by taking at least one from each group

Group – A

Q. 1 6+6+2

a) For each of the truth tables below say whether it is possible for a perceptron to learn the required output. In each case, explain the reason behind your decision.

i)

Input	0	0	1	1
Input	0	1	0	1
Output	1	0	0	1

ii)

Input	0	0	1	1
Input	0	1	0	1
Output	1	1	0	0

iii)

Input	0	0	1	1
Input	0	1	0	1
Output	1	1	1	1

b) A perceptron with two inputs has a threshold level set at the point at which it will fire (i.e. output a one). It is sometimes convenient to always set the threshold level to zero. Show how this can be achieved by describing two perceptions which act in the same way but one has its threshold set to a non-zero figure and the other perceptron has a zero threshold.

c) Why might it be a good idea to build a perceptron with a zero threshold figure?

Q. 2 6+8

a) Let us say that for some reason you need a network with the following characteristics: For input x= $[1\ \ 0\ \ 0]^T$ and its output y=$[2\ \ 3]^T$, For input x= $[0\ -1\ 0]^T$ and its output y=$[1\ \ 0]^T$ and For input x= $[0\ \ 0\ 1]^T$ and its output y=$[0\ \ 5]^T$.
Build this network, i.e. draw its neurons and connections, and indicate the values of all weights in the network. Test the network's interpolative ability by giving it the inputs $[0.5\ 0.5\ 0]^T$ and $[0\ \ -1\ \ -1]^T$ and determine output in each case. If you do not build the network, just write down what you believe its output would have been, and explain why?

b) Prove single layer perceptron convergence theorem.

Q. 3 4+5+5

a) What is the most popular algorithm for training a neural network? What is its principle? Write in detail.

b) Train a 3-input-single-output neural network with a single neuron having the initial weight vector **w1**= $[1, -1, 0]^T$, and two inputs **x1**=$[1, 0, 1]^T$ and **x2**=$[1, 0, -1]^T$ and the desired response for the above two inputs are [d1 d2] = [-1 -1]. Learning rate is assumed to be η=1. Activation function used is a sigmoid function with the slope parameter has the value equal to 1. Train the network using the training algorithm discussed in Q.3 (a).

c) Show how error is back propagated in a multilayer feed forward network?

Group – B

Q. 4 10+4

a) Show a Simple Genetic Algorithm run for the first two generations which solves the following optimization problem: *Big Rectangles: Find the width and height of a rectangle of maximum area, where width and height are integers in the range 0 through 5.* Assume the initial population size is 4.

b) Suppose you are running your GA and notice that after a certain number of generations fitness no longer increases, that is, the algorithm is "stuck". Is this because an optimal solution has been reached? If not -- what might help getting "unstuck"?

6+2+6

Q. 5

a) Suppose the problem is to evolve a binary string of length n which is symmetric. If the string positions are numbered from 0, then a symmetric string will have a 1 in position i if and only if there is a 1 in position *(n-1)-i*. The initial population is the randomly generated set of binary strings of length n, where n is an even number.
   i. Give a suitable fitness function for this problem.
   ii. Will the offspring of parents with a high fitness value generally also have a high fitness value, given your fitness function? Explain your answer.

b) If the population size in a genetic algorithm is restricted to 1, what search algorithm does it corresponds to? Explain your answer.

c) Discuss some drawbacks of the roulette wheel selection mechanism, and describe some methods to avoid (or to minimise) these drawbacks.

Group – C

8+6

Q. 6

a) The fuzzy relation R is defined on sets X_1={a, b, c}, X_2={s, t}, X_3={x, y}, X_4 = {i, j} as follows: R(X_1, X_2, X_3, X_4)=0.4/(b, t, y, i) + 0.6/(a, s, x, i) + 0.9/(b, s , y, i) + 1/ (b, s , y, j) + 0.6/(a, t, y, j) + 0.2/ (c, s, y, i)
   i. Compute the projections $R_{1,2,4}$, $R_{1,3}$ and R_4
   ii. Compute the cylindrical extensions [$R_{1,2,4}$ ↑{X_3}], [$R_{1,3}$↑{X_2, X_4}] and [R_4, ↑{X_1, X_2, X_3}]
   iii. Compute the cylindrical closure from the three cylindrical extensions in (ii)
   iv. Is the cylindrical closure from (iii) equal to the original relation R?

b) For each of the following binary relations on a single set, state whether the relation is reflexive, irreflexive or antireflexive, symmetric, asymmetric or strictly antisymmetric, and transitive, nontransitive or antitransitive.
   i) "is sibling of"; ii) "is a parent of";

5+4+5

Q. 7

a) Write the different fuzzy extension of the inference rules.

b) Assume the two values of the fuzzy variable *Age* are *'Young'* and *'old'* whose membership functions are defined as $\mu_{Young} = e^{-(\frac{x}{20})^2}$ and $\mu_{Old} = e^{-(\frac{x-100}{30})^2}$. Determine the membership function for the fuzzy set "*not very Young and not very Old*".

c) Prove that if R is a fuzzy relation on X and Y then for any fuzzy sets A and B in X and Y, respectively, we have $R \subseteq A \,\alpha\, (A \circ R)$ and $A \circ (A \,\alpha\, B) \subseteq B$. Symbols are of usual meanings. Assume that the height of A is greater than or equal to B.

5+(5+4)

Q. 8

a) Discuss with example two types of de-fuzzyfication methods.

b) The following matrix defines a fuzzy compatibility relation *R* on the set *X = {a, b, c, d}*

$$\begin{bmatrix} 1 & 0.333 & 0.817 & 1 \\ 0.333 & 1 & 0.667 & 0.333 \\ 0.817 & 0.667 & 1 & 0.817 \\ 1 & 0.333 & 0.817 & 1 \end{bmatrix}$$

Find closest transitive relation by using transitive max-min closure. What are the possible partitions of X with this relation?