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MANIPAL INSTITUTE OF TECHNOLOGY
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SEVENTH SEMESTER B.TECH. (E & C) DEGREE END SEMESTER EXAMINATION - NOV/DEC 2016
SUBJECT: SOFT COMPUTING TECHNIQUES (ECE - 425)

TIME: 3 HOURS **MAX. MARKS: 50**

Instructions to candidates
- Answer **ANY FIVE** full questions.
- Missing data may be suitably assumed.

1A. Perform two training steps of delta learning rule of a continuous neuron for λ = 1, η = 0.5. Train the network using the following input –target pairs:

$$X1=\left(\begin{bmatrix}3 & 0 & -1\end{bmatrix}^t\right), d1=-1 \quad X2=\left(\begin{bmatrix}2 & -1 & -1\end{bmatrix}^t\right), d2=1$$

The initial weight vector is given by $W^1=\begin{bmatrix}0 & 1 & 1\end{bmatrix}^t$. Draw the network architecture.

1B. A linear classifier is to be trained to assign X=0, and X=3 to class 1 (d1=1) & 2 (d2=-1) respectively. Display the movement of weight vector on the weight plane starting from the initial weights $w^1 = [1 \quad 0.5]^t$ and follow intermediate steps until weights fall to the solution region. Use c=1.

1C. Write the expression for momentum method used in back propagation algorithm. Explain how it influences the convergence of back propagation learning.

(5+3+2)

2A. Analyse a single feed forward and back propagation step for a two layered feed forward network with the following data: The transposed weight matrices for both the layers are:

1st layer 2nd layer

$$V=\begin{bmatrix}-0.5 & -1\\ 1 & -1\end{bmatrix} \qquad W=\begin{bmatrix}-0.5 & -1 & -1\end{bmatrix}$$

The input to the network p = 0.5 and the bias input is -1. The desired output is d = sin(πp).
Use unipolar continuous neurons in the first layer and f (net) = net in the 2nd layer . Assume η=1.

2B. Design a radial basis function neural network to perform XOR classification. Draw the network architecture.

2C. Mention any two advantages and disadvantages of a probabilistic neural network (PNN).

(5+3+2)

3A. Design a recurrent auto associative memory to store the following patterns:
$s1=[1\ 1-1-1]^t, s2=[-1\ 1-1\ 1]^t, s3=[-1-1-1\ 1]^t$. Perform asynchronous update by considering the test pattern as $s0=[1\ 1\ 1\ 1]^t$. Assume sgn (0) =1. Also determine the energy function in each step.

3B. The initial transposed weight matrix of a Kohenen's feature map is given by:

$$W = \begin{bmatrix} 0.1 & 0.5 & 1 \\ 0.01 & 0.5 & 0.03 \\ 0.9 & 0.6 & 0.1 \end{bmatrix}$$

.Perform single step training for the input vectorX1 = $[1\ 0.05\ 0.4]^t$. Assume α=0.2, R=2. Use Euclidian distance metric to determine the winner.

3C. In evaluating a certain classifier performance, if there are a total of N=100 patterns and the accuracy obtained is 75%, find the cost of classification for the following cost matrix:

Cost matrix	Predicted class		
Actual class	C(i/j)	+	-
	+	-1	100
	-	100	-1

(5+3+2)

4A. A temporal associative memory needs to be designed for recall of the following sequence:
$s^{(1)} = [-1 \quad 1 \quad -1\; -1 \quad 1]^t$, $s^{(2)} = [1 \quad 1 \quad -1 \;\; 1 \quad -1]^t$, $s^{(3)} = [1 \quad -1 \quad -1 \;\; 1 \quad 1]^t$
Compute the weight matrix W and check the recall of patterns in the forward directions. Assume bipolar binary activation function.

4B. Explain how the margin width is determined in linear SVM classifier with illustration.

4C. Explain briefly how the Hamming distance between stored and test patterns affect the retrieval capacity of associative memories.

(5+3+2)

5A. Consider a 2-input 1-output fuzzy system that is constructed from the following 3 rules:

If x1 is A1 and x2 is A2, Then y is A2
If x1 is A2 and x2 is A1, Then y is A1
If x1 and x2 are A1, Then y is A3

Where A1, A2 & A3 are fuzzy sets with membership functions:

$\mu_{A1}(u) = 1 - |u|, if\ -1 \le u \le 1$ $\qquad$ $\mu_{A2}(u) = 1 - |u-1|, if\ 0 \le u \le 2$

= 0 otherwise $\qquad$ = 0 otherwise

$\mu_{A3}(u) = 1 - |u-2|, if\ 1 \le u \le 3$

= 0 otherwise

If the input to the fuzzy system is [x1*, x2*] = [0.9 0.1], use singleton fuzzifier to determine the output of the fuzzy system y* in the following case:

i) Minimum inference engine and center average defuzzifier
ii) Product inference engine and center average defuzzifier

5B. Design a single layer perceptron classifier to perform the following classification using minimum distance Classifier:

$$\left(P1 = \begin{bmatrix} -1 \\ 1 \end{bmatrix}, t1 = -1\right), \left(P2 = \begin{bmatrix} -1 \\ -1 \end{bmatrix}, t2 = -1\right), \left(P3 = \begin{bmatrix} 0 \\ 0 \end{bmatrix}, t3 = 1\right), \left(P4 = \begin{bmatrix} 1 \\ 0 \end{bmatrix}, t4 = 1\right).$$

Test the classifier for the following test vectors:

$$\left(P5 = \begin{bmatrix} 2 \\ 0 \end{bmatrix}, P6 = \begin{bmatrix} -0.5 \\ 1 \end{bmatrix}, P7 = \begin{bmatrix} 0 \\ 1 \end{bmatrix}, P8 = \begin{bmatrix} -1 \\ -2 \end{bmatrix} \right)$$. Draw the network architecture.

5C. Illustrate the difference between:

i) Auto & hetero associative memories

ii) Pattern classification & recognition

(5+3+2)

6A. Design a simple fuzzy system to simulate the nonlinear function $y = 5|x|$ where the input and output universes are defined as x = [-2, 2], y= [0, 10]. Use Mamadani minimum implication, min for all t-norms and max for all s-norms. Find the output by center average defuzzification method. Test the system for the following fuzzy singletons: x= 0,-1 and +2 and determine the simulation error.

6B. Design and test a bidirectional hetero associative memory to store the following pairs of patterns: $A^1 = [1 \quad 1]^t; B^1 = [-1 \quad -1 \quad -1]^t;\ \ A^2 = [-1 \quad -1]^t; B^1 = [1 \quad 1 \quad 1]^t$. Draw the memory architecture.

6C. Using Genetic algorithm, optimize the nonlinear function $f(x) = x^2$, for $0 \le x \le 3$, where x is an integer. Show steps for one iteration only.

(5+3+2)