Max Time- 1 hr 30 min   Max Marks - 60   Date: 09.12.2017

Note: All questions are to be answered in main answer-sheet. All parts of Q1 must be answered in SEQUENCE, Must put NA against the part not attempted.

Q1. Provide One word/Phrase /expression/numeral

a) Mutation operation facilitates which kind of exploration in GA?

b) Concept of "Golden section" is used in which method of optimization?

c) Using Hebbian rule, If $w(n+1) = w(n) [1+ \alpha x^2(n)]$, α is learning rate, what is the type of activation function?

d) Which type of learning is currently used more in relation to Response learning than to Stimulus learning?

e) Which neural network does not use bias input and activation function?

f) Which off-line method in RBFN overcomes many issues in traditional gradient algorithms such as stopping criterion, learning rate, number of epochs and local minima for finding weights between single hidden layer and output layer?

g) Which function in Matlab creates as many radial basis neurons as there are input vectors in pattern vector for RBFN?

h) Name the most commonly used activation function used in RBFN.

i) "One of the strengths of this learning is that it is able to compare the expected utility of the available actions without requiring a model of the environment" is referring to which type of learning?

j) In "Fuzzy Expert System", which block provides fuzzy membership functions for fuzzifier and defuzzifier?

k) In neuro fuzzy air conditioner, after input layer, how many neurons would be required If inputs { temperature, humidity, number of persons) are fuzzified in 5 ,4,3 membership functions?

l) Which matlab command preprocesses the network training set by normalizing the inputs (p) and targets(t) so that they have mean of zero and standard deviation of one?

m) Which module of Expert System enables the user to ask the expert system *How* a particular conclusion is reached and *Why* a specific fact is needed?

n) Which kind of Expert system uses precedence based reasoning?

o) In self-tuned FLC, the set point and output, apart from being used in calculating error and change in error go to which block for scaling inputs and outputs of FLC?

p) Name the factor in BPA which moves weight changes in direction that is combination of current gradient and previous gradient.

q) Experiments of Ivan Pavlov and B F Skinner on animals led to development of which kind of neural network?

r) "Environment's response at (t+1) depends only on State (s) & next state (s') & Action (a) at t" is a description of what kind of processes describing an environment for Reinforcement learning ?

s) Which method of clustering needs calculation of inverse-distance weighting?

t) For Fuzzy sets A & B, Express {1- min[$\mu_A (x)$, $\mu_B (x)$]} in terms of max operation

u) If A= { (a,0.5),(b,0),(c,0.9),(d,0.8) } and B= { (a,0.3),(b,0.1),(c,1),(d,0.7) } then the Bounded difference between A and B is given by:

v) Name the person who suggested to use a single spike, a *singleton*, as the membership function of the rule consequent.

w) Relations that are reflexive and symmetric, but not transitive are called as what?

x) Which Type of fuzzy sets are useful in circumstances where it is difficult to determine the exact membership function for a fuzzy set?

y) In Fuzzy Expert System, when rules are aggregated using Mamdani FLC, which method ensures less information is lost, and hence preserves the original shape of the rule consequent?   [25]

P.T.O.

Q2. Starting with initial weight matrix as Zero, find weight matrix to store following four patterns :

$s(1):t(1) == [1\ 0\ 1\ 0\ 0] : [1\ 0]; \quad s(2):t(2) == [0\ 1\ 1\ 0\ 0] : [1\ 0];$

$s(3):t(3) == [0\ 0\ 0\ 1\ 1] : [0\ 1]; \quad s(4):t(4) == [0\ 0\ 0\ 1\ 0] : [0\ 1]$

(a) Using Hebb learning algorithm (b) Using outer product

(c) Now test the network with [1 1 1 1 1] and comment upon the result. Use binary signum activation function.
$LR = 1$

[12]

Q3. Four 3-D data (x,y,z) [(1 0 0),(0 0 1),(1 1 0), (0 1 1)] are to be classified in two clusters using Kohonen SOM network. Initial weights relating x,y,z to clutser 1 and 2 are [0.5 0.8 0.4] and [0.3 0.5 0.3] respectively. Learning rate is 0.5. Find the weight matrix after presenting first two data. [8]

Q4. Using Perceptron learning , consider storing three patterns X_1 (1 0 1) , X_2 (0 -1 -1) and X_3 (-1 -.5 -1) , with corresponding targets as -1,1 ,1 respectively. Initial weight matrix relating 3-dimensional pattern is (1 -1 0). Find the weight after X_1, X_2 and X_3 are presented in sequence. Weight changes for Perceptron learning are proportional to difference between desired and actual output, and learning rate is 0.1,activation function is signum bipolar. [6]

Q5. For the confusion matrix shown below, Calculate (a) Positive Predictive value (PPV) and (b) Sensitivity for the image "forest" [4]

		Classification results						
		forest	bush	crop	urban	bare	water	unclass
Ground truth	forest	440	40	0	0	30	10	10
	bush	20	220	0	0	40	10	20
	crop	10	10	210	10	50	10	60
	urban	20	0	20	240	100	10	40
	bare	0	0	10	10	230	0	10
	water	0	20	0	0	0	240	10

Q6. Fuzzy relation R relates system hangs (h) and system not booting (b) to computer virus (v) and hard disk crash (c) by hRv (=0.7), hRc(=0.2), bRv(=0.5), bRc(=0.6). Relation S relates v & c to internet(i) and obsolescence (o) by vSi (=0.8), vSo(=0.6), cSi(=0.1), cSo(=0.2). Find the membership value of (i) system hangs because of internet (ii) system does not boot because of obsolescence. [5]

------ End ------

Max Time- 1 hr 30 min   Max Marks - 60   Date: 09.12.2017

Q1. Neural network is to be trained using BPA to identify the alphabet presented plus the next alphabet of word "THIS".

Desired outputs: when T is presented, T at upper node and H at lower node, when H is presented, H at upper node and I at lower node, when I is presented, I at upper node and S at lower node, and when S is presented, S at upper node and 0 (representing space) at lower node.

Input to network is a 9 bit binary representation of alphabets read row-wise from left to right (x=1, 0 otherwise, as shown in figure below). Outputs of network are decimal equivalent of binary representations of alphabets divided by 2^n, where n =9.

```
x  x  x        x     x          x          x  x  x
   x           x  x  x          x          x  x  x
   x           x     x          x          x  x  x
```

(a) Show one forward and backward pass of BPA when alphabet T is presented. Learning rate is 0.6, all initial weights are set as 0.5. There is one hidden layer with one neuron. Activation function at hidden layer is tan sigmoid with steepness factor of 2.0, activation function at output layer is linear function.

(b) Write Matlab code covering only (i) to (iv), when network is to be trained for all characters in word THIS. First hidden layer has 12 nodes, second hidden layer has 6 nodes, activation function at both hidden layer is logsig, activation function at output layer is linear activation function
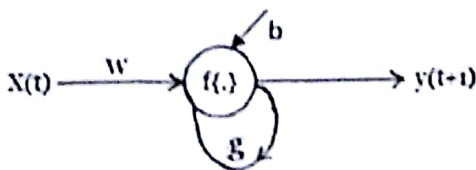
(i) Define pattern and target vector as used in matlab programming

(iii) Define object net using newff command

(iv) Train the net with pattern vector and test for letter H   [15+6]

Q2. A recurrent neural network is shown below.

X(0)=-0.1, X(1)=0.2. y(0)=0. Desired values of y(1) and y(2) are 0.4, 0.6 respectively, b=-0.09, w=g=0.5. Activation function is Relu. (a) Unfold the network (b) Find new values of b, w and g after one iteration of BPTT.   [2+12=14]

P.T.O.

Q3. Consider following optimization problem:

Maximize: $f(x_1, x_2) = (x_1^2 + x_2 - 11)^2 + (x_1 + x_2^2 - 7)^2$

subject to: $0 \leq x_1$, and $x_2 \leq 5$

Genetic Algorithm (GA) is used for solving the problem. A population of 6 members is used and initial population (binary encoded), and random numbers for Roulette wheel are given below in Table-1.

String no	Initial x1 (binary)	Initial x2 (binary)	Random no. for Roulette wheel
1	0110101001	0100011100	0.2091
2	0010101010	0000011010	0.8582
3	0000101010	0100011011	0.5339
4	1100011111	0101010100	0.7847
5	0100011100	1011100010	0.2333
6	1110010101	1001100101	0.4476

Table-1

Elite count is 1. Cross over probability is 0.8 and mutation probability is 0.05. Crossover site for first cross over is 15, and for second cross over it is 5. Bit 9 has probability less than 0.05 for mutation parent 1.

(a) Find Crossover Count (CC) and Mutation Count (MC)

(b) Perform one iteration of GA and write your results in form of Table-A with columns as (1) string number, (2) x1 actual, (3) x2 actual, (4) fitness value, (5) probability of selection, (6) cumulative probability, (7) string number selected in mating pool.

(c) Write next generation population in form of Table-B with columns as (1) type of child, (2) x1 binary, (3) x2 binary, (4) x1 actual, (5) x2 actual.

(d) Write x1 actual, and x2 actual values of the string, which will be elite in iteration 2.   [1+12+6+1]

Q4. Consider following optimization problem:

Minimize: $f(x_1, x_2) = x_1 - x_2 + 2x_1^2 + 2x_1x_2 + x_2^2$

subject to: $0 \leq x_1$, and $x_2 \leq 6$

Particle Swarm Optimization is used for solving this problem. Initial positions (X1, X2), velocities (V1, V2) and random numbers (R1, R2) used in PSO are given in Table 2.

S.N.	X1	X2	V1	V2	R1	R2
1	1	2	0.5	1	0.0497	0.5126
2	2	1	1	0.5	0.5138	0.0621
3	3	3	1.5	1.5	0.7578	0.7768
4	4	5	2	2.5	0.9917	0.6320
5	5	4	2.5	2	0.2520	0.4537

Table-2

Given, $c_1 = c_2 = 1.05$, $w_{max} = 1.0$, $w_{min} = 0.4$

(a) Find global best position.

(b) Perform one iteration of PSO and tabulate your results in form of a table with columns as updated V1, updated V2, next generation X1, next generation X2.   [1+4]

------- End -------

Q1. Points on line y=x at x=2,3,6,9,10,11 are to be clustered in two clusters using Fuzzy C means method. Initial centroids are (3,3) and (11,11)

  a) Perform one iteration and find the membership degree of each point to two clusters in tabular form with column title as (i) point (ii)membership degree to cluster 1(iii) membership degree to cluster 2

  b) Calculate new centroids after one iteration   [12+4=16]

Q2. Consider an unknown system with two inputs x_1 and x_2 and single output y. Membership functions for x_1 and x_2 are shown in figure below:
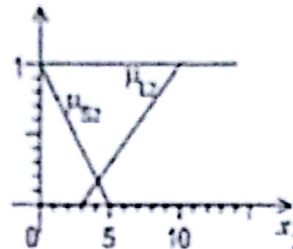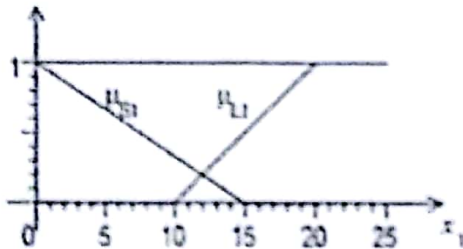
Fuzzy rules from experience are:
R1: If x_1 is small and x_2 is small then $y = x_1 + x_2$
R2: If x_1 is large then $y = (1/2) x_1$
R3: If x_2 is large then $y = (1/3) x_2$
For $x_1 = 13$ and $x_2 = 4$, calculate 'y' using centroid method of defuzzification.   [12]

Q3. Fuzzy set A defined as "A is small" is represented as:

A = {1.0/1 + 0.7/2 + 0.3/3 + 0.0/4)

Relationship "A and B are approximately equal" is reflexive and symmetric with membership degree of 0.5 for (1,2), (2,3), (4,3), all others membership degrees are zero.

  a) Write the Relationship matrix
  b) Find membership degrees (B1, B2, B3, B4) of Fuzzy set B defined as "B is somewhat small" and represented as B ={ B1/1 + B2/2 + B3/3 + B4/4) using max-min composition.   [12]

BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI
Neural Network & Fuzzy Logic BITS F312 [2017-2018]
**Mid-Semester Test - Part 1 (closed book)**

Max Time-45 min   Max Marks - 50   Date: 12.10.2017

D

Please read the instructions given on answer sheet carefully.

Name: Aditya Wagh   ID: 2015A8PS382P

Q1. In velocity algorithm of PID controller, the term corresponding to integral term is proportional to

(a) $c_n - c_{n-1}$ (b) c_n (c) $c_n - 2c_{n-1}$ (d) $c_n + c_{n-1}$

Q2. Which of the following Defuzzification method is applied for symmetric output membership functions

(a) Middle of maxima   (b) Maximum membership   (c) Centroid   (d) Weighted average

Q3. Which of the following statement is NOT correct

(a) Probability measures the likelihood that a future event will occur.
(b) Fuzzy logic measures the ambiguity of events that have already occurred.
(c) Sum of membership degrees of distinct elements of universe of discourse must add up to unity
(d) Probabilities for mutually exclusive events must add up to unity.

Q4. According to DeMorgan's Law $\overline{A \cap B}$ for fuzzy sets A and B would be

(a) min[μ_A (x), μ_B (x)]= max [(1- μ_A (x)), (1 - μ_B (x))]   (b) 1- max[μ_A (x), μ_B (x)]= min [(1- μ_A (x)), (1 - μ_B (x))]
(c) 1- max[μ_A (x), μ_B (x)]= min [μ_A (x)), μ_B (x))]   (d) min[μ_A (x), μ_B (x)]= min [μ_A (x)), μ_B (x))]

Q5. If fuzzy set A defines "LARGE", then to get "NOT LARGISH " and "VERY LARGE", following operations would be done respectively on fuzzy set A

(a) con(A), dil(A)   (b) dil(a), con(A)   (c) 1-con(A), dil(A)   (d) 1-dil(A), con(A)

Q6. Which is NOT true about Type 2 Fuzzy sets

(a) In type-2 fuzzy sets, the degree of membership is in itself fuzzy and is represented by what is usually referred to as a secondary membership function
(b) If the secondary membership function is at its maximum of 1[defined] at every point, we speak of an interval type-2 set
(c) Generalized type 2 fuzzy set has the fuzzy membership grade as a crisp interval between zero and one
(d) Type-2 fuzzy sets are useful in circumstances where it is difficult to determine the exact membership function for a fuzzy set.

Q7. If fuzzy set A is 0.1/-2 + 0.4/-1 + 0.8/0 + 0.9/1 + 0.3/2, then fuzzy set B defined by $f(x) = (x^2 - 3)$ would be

(a) B= 0.8/-3 + 0.9/-2 + 0.1/1   (b) B= 0.8/-3 + 0.9/-2 + 0.3/1
(c) B= 0.8/-3 + 0.4/-2 + 0.1/1   (d) B= 0.8/-3 + 0.4/-2 + 0.3/1

Q8. Which of the following is not a performance measure of control system performance

(a) Rise time   (b) Overshoot   (c) Linearity   (d) Steady state error

Q9. If fuzzy sets A and B are defined as A= { 0.3/a + 0.4/b + 0.8/c } B= { 0.2/a + 0.5/b + 0.6/c }; Then degree to which A is subset of B is

(a) 0.8   (b) 0.92   (c) 0.6   (d) NOTA

Q10. Fuzzy set A in two-dimension space is (0.4,0.8), Entropy of A is

(a) 3/14   (b) 4/14   (c) 5/14   (d) NOTA

Q11. Relationship " X is divisible by Y"

(a) Is reflexive, symmetric, and transitive   (b) Is reflexive, not symmetric, is transitive
(c) Is not reflexive, not symmetric, is transitive   (d) NOTA

Q12. Approximately 2" = 0.5/1 +1/2 + 0.5/3, Approximately 4" = 0.8/2 +0.9/3+1/4, then in " approximately 8" fuzzy set, membership degree of number 4 and 6 are respectively

(a) 0.8, 0.5   (b) 0.5,0.9   (c) 0.8,0.9   (d) NOTA

P.T.O.

Q13. Matlab command of C1 = randn (100, 2) + 1; C2 = randn (100, 2) - 1; will generate 100 two dimensional points, which when plotted on same graph will have maximum range of both x and y as
    (a) -3 to 3   (b) -2 to 2   (c) -1 to 1   (d) NOTA

Q14. In Fuzzy Logic Control System, output of sensor, and output of defuzzifier respectively go to
    (a) Fuzzifier, Inference mechanism
    (b) Inference mechanism, sensor
    (c) Fuzzifier, actuator
    (d) NOTA

Q15. Consider the total number of test images from the authorized database as P and the number of test images from the impostor database as N, then PPV and TPR are given respectively by
    (a) TP/ (TP+FP), TP/(TP+FN)
    (b) TP/(TP+FN), TN/(TN+FP)
    (c) TP/(TP+FN) , TP/ (TP+FP)
    (d) NOTA

Q16. Combined representation of TPR and precision is given by
    (a) FPR   (b) PPV   (c) TNR   (d) NOTA

Q17. Activation function defined by f(x)= max(αx,x), α=0.01 defines which of the following activation function
    (a) Logsig   (b) Tansig   (c) Purelin   (d) NOTA

Q18. Derivative of activation function tansig defined by $y = \dfrac{2}{1+\exp(-2x)} - 1$ is

    (a) y(1-y)   (b) 0.5(1-y^2)   (c) y(1-y^2)   (d) NOTA

Q19. Two binary inputs (0/1) with unity weights applied to a Neuron with threshold of 1.5 will realize gate type X, and with threshold of 0.5 will realize gate type (Y)
    (a) X (OR) , Y(AND)   (b) X(AND), Y(OR)   (c) X (OR) , Y (NAND)   (d) NOTA

Q20. Fuzzy sets A={1/a, 0.3/b, 0.2/c 0.8/d, 0/e} and fuzzy set, B = {0.6/a, 0.9/b, 0.1/c, 0.3/d, 0.2/e}; Support of A and Core of B respectively are
    (a) supp(A) = {a, b, c, d,e }, core(B) = {a,b,c,d,e}   (b) supp(A) = {a, b, c, d }, core(B) = {a,b,c,d,e}
    (c) supp(A) = {a, b, c, d }, core(B) = {Null}   (d) NOTA

Q21. For Fuzzy set A = 0.0/ − 2 + 0.3/− 1 + 0.6/0 + 1.0/1 + 0.6/2 + 0.3/3 + 0.0/4; [A]$_\alpha$ if 0 ≤ α ≤ 0.3 is
    (a) {0, 1}   (b) {1}   (c) {-1,0,1,2}   (d) NOTA

Q22. Let Fuzzy set A ={1,2,3} represented as A = 1/0.4 +2/1 +3/0.3; Cardinality of set A, and cardinality of power set of A respectively would be
    (a) 1.7,3   (b) 6,8   (c) 6,3   (d) NOTA

Q23. Consider Y = {1, 2, 3, 4,5} and C - a subset of Y is C = 0.6/1 + 0.8/2 + 1/3 + 0.6/4; then complement of C is
    (a) 0.4/1 + 0.2/2 + 0.4/4 + 0/5
    (b) 0.4/1 + 0.2/2 + 0/3 + 0.4/4
    (c) 0.4/1 + 0.2/2 + 0/3+ 0.4/4 + 0/5
    (d) NOTA

Q24. Fuzzy set A and b are defined as A={(1,2), (0.5,3),(0.4,4), (0.1,5)} , B= (0.5,2), (0.7,3), (0.2,4), (0.4,5)}, Fuzzy set defined as "B difference A" would be
    (a) { (0,2),(0.5,3),(0.2,4),(0.4,5) }
    (b) { (0.5,2),(0.7,3),(0.6,4),(0.9 ,5) }
    (c) { (0.5,2),(0.3,3),(0.4,4),(0.1,5) }
    (d) NOTA

Q25. Fuzzy sets A and B are defined as A = {(0.2, a), (0.4,b), (0.5,c),(0.6,d),(0.1,e) } and B = { (0.8, a), (0.6,b), 0.5,c),(0.4,d),(0.9,e)}

    a) $(\overline{A \cup B})_{0.6}$ = {a,b,c}
    b) $(\overline{A} \cup \overline{B})_{0.6}$ = {b,c,e}
    c) $(\overline{A} \cup \overline{B})_{0.6}$ = {a,b,e}
    d) NOTA

BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI
Neural Network & Fuzzy Logic BITS F312 [2017-2018]
Mid-Semester Test - Part 1 (Answer sheet)

D

Max Time-45 min   Max Marks - 50   Date: 12.10.2017

Name: Aditya Wagh   ID: 2015A8PS382P

Instructions:
- Make sure that set number on your question paper and answer sheet match.
- Overwritten answers will be considered Not attempted, so be careful when putting final answers in answer sheet.
- Write NA for question not attempted.
- It contains 25 multiple choice questions. Each question has only one correct answer. For Q1 to Q17, write only the answer choice. For Q18 to 25, if NOTA is the correct choice, then you have to write the actual answer in the space provided.
- Correct answer carries TWO marks.
- Wrong answer carries minus half mark.
- If NOTA (None of The Above) is the correct choice then,
1. NOTA choice accompanied by correct answer carries two marks.
2. NOTA choice accompanied by wrong answer carries minus half mark.
3. NOTA choice without any answer carries zero mark.
- Be very careful where answers are to be given in order of respective items.

$10 \times \frac{2}{6} + 0.5 \cdot -\frac{3}{3} = \frac{20}{3}$ (17)

Q. No.	Answer Choice	Q. No.	Answer Choice	Actual Answer (if NOTA)
1	B	9	NA	
2	B ✗	10	NA	
3	C	11	B	
4	B	12	NA	
5	D	13	NA	
6	C	14	C	
7	A ✗	15	C ✗	
8	C	16	NA	
		17	NA	
		18	NA	
		19	NA	
		20	C	
		21	D ✗	$\{-2, -1, 3, 4\}$
		22	D NA	
		23	B ✗	
		24	A	$1.7, 5.1$
		25	D ✗	$(\bar{A} \cup \bar{B}) = \{a\}$ ✗ 0.6