BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI

Neural Networks & Fuzzy Logic (BITS F312) [1st Semester, 2022-2023]

Comprehensive Exam - Part A (Closed Book)

Max Time- 45 min | Max Marks - 40 | Date: 21.12.2022

- **Wherever applicable, Calculations MUST be shown along with the answer**
- **Questions MUST be Answered Sequentially**

Q1. In a fruit box, there are 950 apples and 50 oranges. The classification model classifies each fruit as an apple. Find (i) Accuracy of Classifier (ii) Recall of Apple & Orange [2+1+1=4M]

Q2. Identify the performance parameter 'X' . S*how the proof*. *No marks without proof.* [3M]

$$X = \frac{PR}{P + R - PR}; P = precision, R = recall$$

Q3. For Hopfield network, Write the weight matrix to store two samples :

(1, -1, 1, 1) and (-1, 1, -1, 1). *Show the calculations. No marks without showing calculations.* [3M]

Q4.. Reward matrix for travelling through nodes is given below, rewards are 0 or 100 and '-' means no connection between nodes. Destination is node F, discount factor is 0.5

$$\mathbf{R} = \begin{array}{c} state \setminus action \\ A \\ B \\ C \\ D \\ E \\ F \end{array} \begin{array}{c} \begin{array}{cccccc} A & B & C & D & E & F \end{array} \\ \begin{bmatrix} - & - & - & - & 0 & - \\ - & - & - & 0 & - & 100 \\ - & - & - & 0 & - & - \\ - & 0 & 0 & - & 0 & - \\ 0 & - & - & 0 & - & 100 \\ - & 0 & - & - & 0 & 100 \end{bmatrix} \end{array}$$

(a) Write formula for Q(state, action) (b) For episode 1 : B-->F, calculate Q(B,F)

(c) For episode 2 : D-->B-->F. calculate Q(D,B) [3M]

Q5. For LSTM, input x(t) is [80 x 1] , output h(t) is [12 x 1], bias is present. Calculate the number of parameters to be learnt. [2M]

Q6. Name two gates in GRU [2M]

Q7. Input tensor of shape (CxHxW) is passed through Global Average Pooling, Write the shape of output tensor in form of input tensor shape. [1M]

Q8. Name the theorem used in RBFN, which states: A non-linearity separable problem (pattern classification problem) is highly separable in high dimensional space than it is in low dimensional space. [1M]

Q9. Name the factor which tells how much the kernel is inflated, which in turn skips some of the points in input.

[1M]

Q10. In CNNs which layer is most prone to overfitting? [1M]

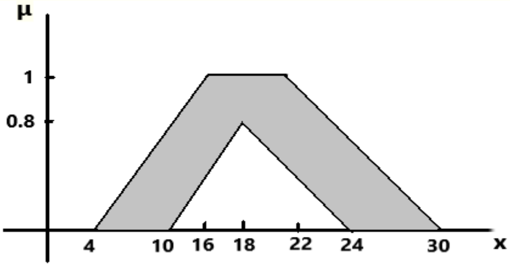
Q11. Which activation function is a self-normalizing activation function for deep neural networks? [1M]

Q12 For each pixel in an image, which process estimates the probability that the pixel belongs to a set of defined object classes? [1M]

Q13. Write the name of learning also known by "fine tuning". [1M]

Q14. A model with high 'X' may represent the data set accurately but could lead to overfitting to noisy or otherwise unrepresentative training data. Identify 'X' . [1M]

Q15. a) Sample the given footprint of uncertainty at values {5, 10, 15, 20, 25} to obtain an Interval Type-2 fuzzy set $\tilde{A}$. [5M]



b) Continuing from Q15.a), compute [3M]

$\tilde{A} \cdot \bar{\tilde{A}}$ using algebraic product t-norm

$\tilde{A} + \bar{\tilde{A}}$ using maximum s-norm

Q16. What is the full form of ANFIS? What type of inference method does it use? [2M]

Q17. One objective of fuzzy PID control is to produce a nonlinear control action. True/False? [1M]

Q18. Fuzzy C-Means clustering is formulated as a constrained optimization problem. True/False? [1M]

Q19. The social component of PSO is explorative or exploitative? [1M]

Q20. PSO cannot be used if the problem has both equality and inequality constraints. True/False? [1M]

Q21. Which one between steepest descent and Lagrange multiplier methods is a gradient based method? [1M]

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Neural Networks & Fuzzy Logic (BITS F312) [1st Semester, 2022-2023]

Comprehensive Exam - Part B (Open Book)

Max Time- 2 hrs 15 min   Max Marks - 80   Date: 21.12.2022

Q1. For the table given below for CNN, Provide information of A,B,C,D,E,F,G. bias is present. [2+2+2+2+2+2+1=13M]

SN		Activation shape	No. of parameters to learn
1	Input	(32,32,3)	0
2	CONV1(f=5,s=1,p=0,no. filters=k= 8)	A(W,H,k)	B
3	POOL1 C=(f, s,k)	(14,14,8)	0
4	CONV2(f=6,s=2,p=0,no. filters=k= 16)	D = (W,H,k)	E
5	FC1	(120,1)	F
7	softmax	(10,1)	G

Q2. Actual monthly sale of product A varying between 100 to 600 units per month for the year 2000 is available to train GRU. When GRU is presented with actual sale of product A for month of Feb, along with predicted sale of product A for month of Feb, given by hidden unit of previous cell, GRU predicts sale of product A for month of March. Given: Actual sale for month of Feb =500, predicted sale for month of Feb =550. Initial weights associated with hidden state are 0.1 and associated with input are 0.2 .Calculate the predicted sale for month of March obtained by GRU in terms of units of product A. *Normalize/Denormalize the data using min-max (0-1) normalization.*

[10M]

Q3. Using Kohenon SOM, RGB data is used to put chocolates in two clusters/classes: brown or white.

Initial weight matrix is: [(0.2, 0.6.0.5),(0.8,0.4,0.7)], learning rate is 0.5, which is reduced by 20% after each epoch. *Normalize the input using min-max(0-1) normalization.*

(a) Draw the architecture of SOM

(b) For a particular RGB value (210,105,30) of a chocolate, find BMU based on Euclidean distance calculations.

(c) Write the updated weight matrix. [9M]

Q4. In RNN cell, activation function used is ReLU. Output derived from hidden state vector is scalar and activation function for calculating output is Linear. At $t=t_2$, input at is 0.5 and the hidden state vector at $t=t_1$, is : (0.1,0.2,0.3).

Desired output at $t=t_2$ is 0.8. Initial weights associated with hidden state to RNN cell are 0.1, associated with input to RNN cell are 0.2 and associated with output state are 0.3. NO bias.

(a) Write weight matrices associated with input (W_x), with hidden state (W_h) and with output state (W_y)

(b) Calculate hidden state vector at $t=t_2$

(c) Calculate output vector 'y' at $t=t_2$

(d) Calculate loss 'L'$=0.5(y-y_d)^2$ at $t=t_2$

(e) Calculate derivative of Loss 'L' at $t=t_2$ w.r.t weights in W_y [3+3+2+2+3=13M]

Q5. To maximize the objective function $f(x_1, x_2) = x_1^2 x_2$ ($x_1, x_2 \in [0, 10]$) using BCGA, the following population is obtained at the present generation. [17M]

10011101

11100110

01001001

00111100

10101010

01011111

where the design variables are encoded as 4-bit binary substrings. If the mutation probability (P_m) was 5% in the previous generation, update it at the present generation using fuzzy logic and considering the rule base given below.

If PDM-1 is Low And PDM-2 is Low Then ΔP_m is Negative

If PDM-1 is Low And PDM-2 is High Then ΔP_m is Zero

If PDM-1 is High And PDM-2 is Low Then ΔP_m is Zero

If PDM-1 is High And PDM-2 is High Then ΔP_m is Positive

(ΔP_m is the change in P_m and PDM stands for phenotypic diversity measure)

Assume triangular membership functions for the inputs. For the output, assume a range of [-5%, 5%] and singleton membership functions.

Q6. The following five data points in a 3D feature space are to be clustered in three hard clusters using an RCGA based K-Means algorithm.

(8,3,6); (3,9,8); (3,7,1); (4,5,6); (2,3,5)

Compute the fitness of the following two chromosomes found in the population at a particular generation.

2	2	7	0	4	3	2	6	6

1	5	3	4	3	5	9	7	0

(No need to normalize the data set) [18M]

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