National University of Computer and Emerging Sciences, Lahore Campus

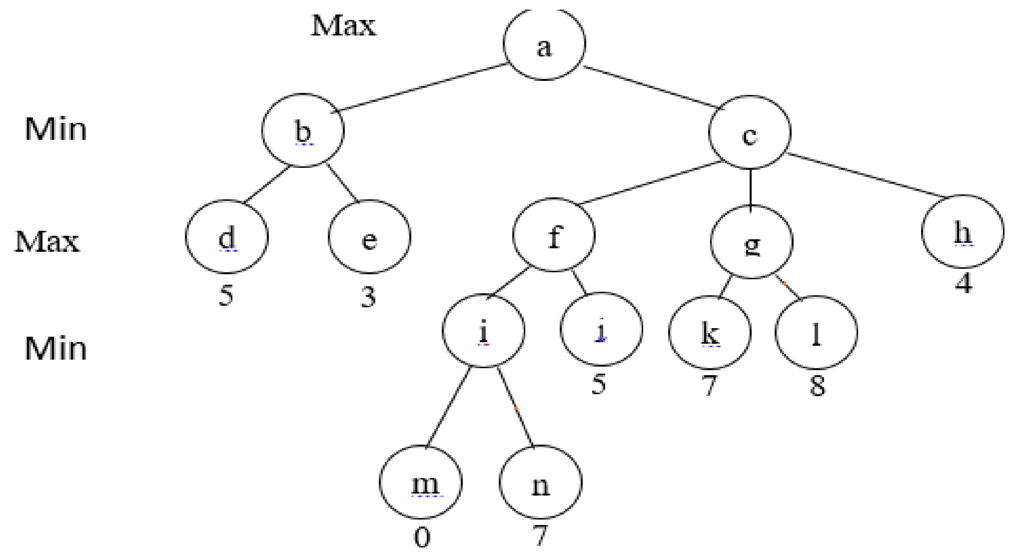
	Course Name:	Artificial Intelligence	Course Code:	AI2002
	Program:	BS (CS) BS(DS)	Semester:	Spring 2023
	Duration:	60 Minutes	Total Marks:	50
	Paper Date:	11-Apr-2023	Weightage	15
	Section:	ALL	Page(s):	5
	Exam Type:	Mid II		

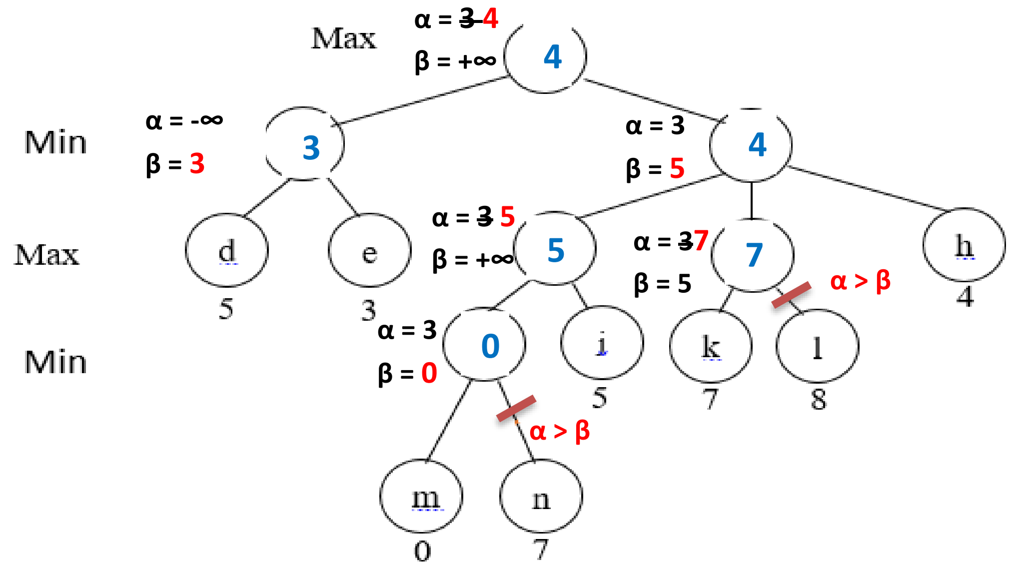
Question	Q1 (CLO:2)	Q2 (CLO:3)	Q3 (CLO:2,3)	Total Marks
Marks	10	15	25	50
Obtained Marks				

Student Name: ______________________________ **Section:** __________ **Roll No.**________________

Do not use pencil or red ink to answer the questions**.** In case of confusion or ambiguity make a reasonable assumption. *Attempt **all questions** on the question paper in space provided.*

QUESTION 1: Perform the alpha beta pruning on the following min-max tree and show all working. **(10)**

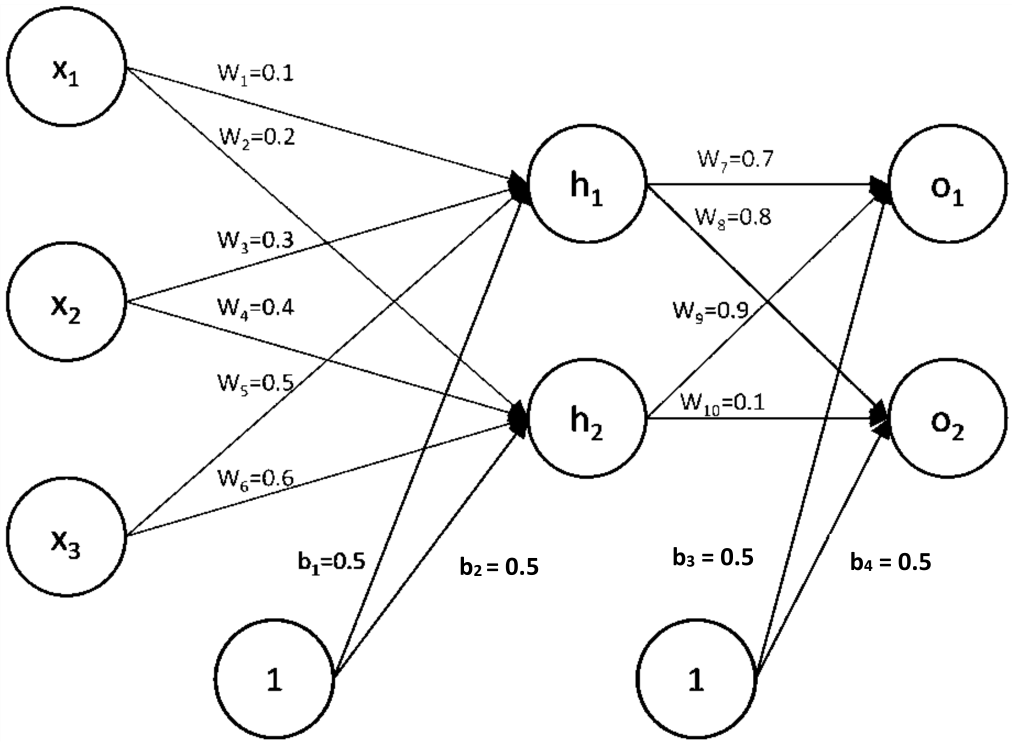




QUESTION 2: Suppose there are 10 chromosomes with finesses as shown in table. What will be the selection probability according to the proportionate and linear rank selection methods? **(5 + 10)**

Chromosome No.	Fitness fi	Proportionate	Linear Rank	Linear Rank Calculations		
		$p_i = f_i / \sum_{j=1}^{n} f_j$		Sort	$nf_i = (P - r_i) + 1$	$np_i = nf_i / \sum_{j=1}^{n} nf_j$
A	50	0.05	0.055	250	10	0.182
B	25	0.025	0.036	140	9	0.164
C	25	0.025	0.018	125	8	0.145
D	100	0.1	0.109	110	7	0.127
E	75	0.075	0.073	100	6	0.109
F	125	0.125	0.145	100	5	0.091
G	250	0.250	0.182	75	4	0.073
H	110	0.110	0.127	50	3	0.055
I	140	0.140	0.164	25	2	0.036
J	100	0.1	0.091	25	1	0.018
Total	1000	1	1	1000	55	1

QUESTION 3: A Multi-layer feed-forward neural network with initialization of weights is given below.



a) Do a forward pass and compute the output at O_1 and O_2. Use linear activation function at hidden layer $\boldsymbol{h_1}$, and $\boldsymbol{h_2}$ and sigmoid activation function at $\boldsymbol{O_1}$ and $\boldsymbol{O_2}$. All biases are 0.5, the input values are x1 = 1, x2 = 4, x3 = 5 and target values are t1= 0.1, t2 = 0.05. Show all the working. **(3+3)**

$$net\_h_1 = (0.1 \times 1) + (0.3 \times 4) + (0.5 \times 5) + (0.5 \times 1) = 4.3$$
$$\boldsymbol{O(net\_h_1) = 4.3}$$

$$net\_h_2 = (0.2 \times 1) + (0.4 \times 4) + (0.6 \times 5) + (0.5 \times 1) = 5.3$$
$$\boldsymbol{O(net\_h_2) = 5.3}$$

$$net\_O_1 = (0.7 \times 4.3) + (0.9 \times 5.3) + (0.5 \times 1) = 8.28$$
$$\boldsymbol{O(net\_O_1) = \frac{1}{1 + e^{-8.28}} = 0.9997}$$

$$net\_O_2 = (0.8 \times 4.3) + (0.1 \times 5.3) + (0.5 \times 1) = 4.47$$
$$\boldsymbol{O(net\_O_2) = \frac{1}{1 + e^{-4.47}} = 0.9887}$$

b) What are the general weight update equations according to delta rule for this network? **(2+2)**

$$\boldsymbol{Error_j = \frac{1}{2}(t_j - O_j)^2}$$
learning rate $= \boldsymbol{\eta}$

Weight update equation for Output Layer unit ***i*** to ***j***

$$\boldsymbol{new\_w_{ij} = old\_w_{ij} + \Delta w_{ij}}$$
$$\boldsymbol{\Delta w_{ij} = -\eta\left(\frac{\partial Error}{\partial w_{ij}}\right) = \eta[(t_j - O_j)\,.\,\sigma\,(net_j)(1 - \sigma\,(net_j)\,)\,.\,O(net_i)]}$$

Weight update equation for Hidden Layer unit ***k*** to ***i***

$$\boldsymbol{new\_w_{ki} = old\_w_{ki} + \Delta w_{ki}}$$
$$\boldsymbol{\Delta w_{ki} = -\eta\left(\frac{\partial Error}{\partial w_{ki}}\right) = \eta\left[\sum_{j=1}^{2}(t_j - O_j).\,\sigma\,(net_j)(1 - \sigma\,(net_j)\,).\,w_{ij}\right].(1).\,x_k]}$$

c) Do a backward pass (backpropagation) and compute update in weights $\boldsymbol{b_1}$, $\boldsymbol{w_4}$ and $\boldsymbol{w_{10}}$. Use learning rate η=0.01. Show all the working. **(5+5+5)**

$$new\_w_{10} = 0.1 + 0.01 \times (0.05 - 0.9887) \times 0.9887 \times (1 - 0.9887) \times 5.3$$
$$new\_w_{10} = 0.1 + 0.01 \times (-0.9387) \times 0.9887 \times (0.0113) \times 5.3$$
$$new\_w_{10} = 0.1 - 0.000556 = 0.0994$$
$$new\_w_{10} = 0.09944$$

$$new\_w_4 = 0.4 + 0.01 \times [(0.1 - 0.9997) \times 0.9997 \times (1 - 0.9997) \times 0.9 + (0.05 - 0.9887) \times 0.9887 \times (1 - 0.9887) \times 0.1] \times 4$$
$$new\_w_4 = 0.4 + 0.01 \times [-0.000243 - 0.00105] \times 4$$
$$new\_w_4 = 0.4 - 0.0000517 = 0.39995$$
$$new\_w_4 = 0.39995$$

$$new\_b_1 = 0.5 + 0.01 \times [(0.1 - 0.9997) \times 0.9997 \times (1 - 0.9997) \times 0.7 + (0.05 - 0.9887) \times 0.9887 \times (1 - 0.9887) \times 0.8]$$
$$new\_b_1 = 0.5 + 0.01 \times [-0.000189 - 0.00839]$$
$$new\_b_1 = 0.5 - 0.0000858 = 0.49991$$
$$new\_b_1 = 0.49991$$

Rough Sheet 1