Department of Computer Science

M.Sc./MCA II Semester Mid-Term Test 2024-25

Paper:CS208-Artificial Intelligence

Time:1 Hour **Marks:20**

1 Consider the following problem:

Tower of Hanoi is a mathematical puzzle where we have three rods and n disks. The objective of the puzzle is to move the entire stack to another rod, obeying the following simple rules:

i. Only one disk can be moved at a time.

ii. Each move consists of taking the upper disk from one of the stacks and placing it on top of another stack i.e. a disk can only be moved if it is the uppermost disk on a stack.

iii. No disk may be placed on top of a smaller disk

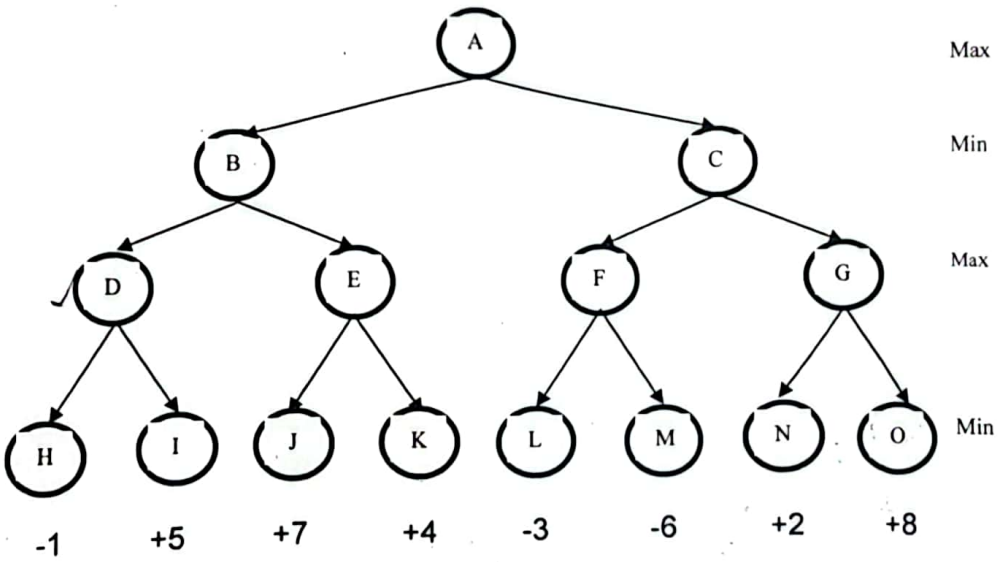
a) Design a suitable state space representation. 2

b) Analyze the problem with respect AI characteristics. 4

2 "Problem solving can be viewed as state space search" Explain the statement in light of problem that A.I. addresses. 4

3 What is AND-OR graph? Why A* algorithm is not sufficient to search AND-OR graph? 4

4 Write the Minimax with Alpha-Beta pruning procedure and explain this procedure by tracing recursive steps on the game tree given below: 2+4



Mid-Term Examination, M.Sc. Sem-II, 2024-25
CS-203: Design and Analysis of Algorithms

Time: 1-hour **Maximum Marks: 20**

1. What is the best case, average case and worst-case time complexity of quicksort? Why is quicksort preferred over merge-sort? Explain. Prove that quicksort runs in $O(nlogn)$ time when the partition is proportional in every recursive call.

2. Give asymptotically tight bound for the following recurrences:
   a. $T(n) = T\left(\frac{n}{3}\right) + T(\frac{2n}{3}) + cn$
   b. $T(n) = 8T\left(\frac{n}{2}\right) + \theta(n^2)$

MCA/MSc. (CS) Semester-II Examination 2022-23
CS322: Deep Learning

Time: 1 hour **20 marks**

1. Using the given predicted and actual class labels for a binary classification model, determine the True Positives (TP), True Negatives (TN), False Positives (FP), and False Negatives (FN). Then, calculate the Accuracy, Precision, Recall, and F1-score. The actual labels are: [1, 0, 1, 1, 0, 1, 0, 1, 0, 1], and the predicted labels are: [1, 0, 1, 0, 0, 1, 0, 1, 1, 1]. [4 marks]

2. Apply SGD to minimize the function $\mathcal{J}(\theta) = (\theta_1 - \theta_2 - 3)^2$, where $\theta = (\theta_1, \theta_2) \in \mathbb{R}^2$. Perform two iterations of SGD and show all intermediate calculations, including the gradient and the updated values of θ_1, θ_2 at each step. [4 marks]

3. Consider the following neural network:

$$z_1 = W_1 x^{(i)} + b_1, \qquad a_1 = \tanh(z_1), \qquad z_2 = W_2 a_1 + b_2, \qquad \hat{y}^{(i)} = \text{softmax}(z_2)$$

The loss function is given by: $L^{(i)} = -\sum_{j=1}^{C} y_j^{(i)} \log\left(\hat{y}_j^{(i)}\right)$, $\qquad J = \frac{-1}{m}\sum_{i=1}^{m} L^{(i)}$

where: $x^{(i)}$ is an input example of shape $(D_x = 200) \times 1$. $y^{(i)}$ is a one-hot encoded label vector of shape $(C = 10) \times 1$. $m = 1000$ is the number of examples in the dataset. The hidden layer has $D_{a_1} = 20$ neurons, meaning z_1 has shape $D_{a_1} \times 1$.

Based on the given information, answer the following questions:

(a) What are the shapes of W_1 , b_1 , W_2 , b_2? If we were vectorizing this network across multiple examples, what would the shapes of the weights/biases be instead? [2 marks]

(b) How many trainable parameters does the model have in total? [2 marks]

(c) How does the number of parameters change if we add another hidden layer with 50 neurons? [1 marks]

(d) What is $\partial J/\partial \hat{y}^{(i)}$? Refer to this result as $\partial_1^{(i)}$. Using this result, what is $\partial J/\partial \hat{y}$? [1 marks]

(e) What is $\partial \hat{y}^{(i)}/\partial z_2$? Refer to this result as $\partial_2^{(i)}$. [1 marks]

(f) What is $\partial z_2/\partial a_1$? Refer to this result as $\partial_3^{(i)}$. [1 marks]

(g) What is $\partial a_1/\partial z_1$? Refer to this result as $\partial_4^{(i)}$. [1 marks]

(h) What is $\partial z_1/\partial W_1$? Refer to this result as $\partial_5^{(i)}$. [1 marks]

(i) What is $\partial J/\partial W_1$? Refer to this result as $\partial_6^{(i)}$. [2 marks]

M.Sc. II/MCA II Sem. Mid Term Examination 2025, Department of Computer Science, BHU

Answer all questions **CS341: Image Processing** **Max. Marks: 20; Time allotted: 1 hr**

1. (a) A 6-bit grayscale image with dimensions 512×512 is saved without compression. What is the total file size in kilobytes (KB)? How many different gray levels are possible in this image? [2]

   (b) Describe the role of the cornea, pupil, lens, and retina in the process of image formation. [2]

2. (a) Explain the significance of image sampling and quantization with suitable example. [2]

   (b) Explain the difference between spatial resolution and gray-level resolution in digital images. Consider an image with a high spatial resolution but low gray-level resolution. What kind of artifacts or issues might you observe in the image? [2]

3. What is Histogram equalization? Perform Histogram equalization on a 3-bit grayscale image of dimensions 5×5 whose grey level distribution is as follows: [4]

Gray level	0	1	2	3	4	5	6	7
No. of pixels	6	5	4	4	1	2	1	2

   Plot the histograms of both the original and equalized images to compare the contrast improvement.

4. (a) In general, what would be the effect on the histogram of an image if we set to zero the lower order bit planes. Perform bit plane slicing on the 3-bit image segment $\begin{bmatrix} 4 & 2 & 3 \\ 2 & 1 & 1 \\ 1 & 3 & 5 \end{bmatrix}$. [2]

   (b) Discuss the basic intensity transformation functions. [2]

5. Explain the Following in the Context of Image Processing: i. Connectivity ii. Distance Measures [4]