Department of Computer Science and Engineering, MNIT
Mid Term Examination, M.Tech (CSE, CSIS) 2023
Subject: Advanced Data Structure and Algorithms

Date and time:9 Oct, 2023 (10:30am 12:00pm) *Max Marks: 30*

(Q1 5x1, Q2 5+5, Q3 2x5 Q4 2x5; Q5 2x5)

Note: Attempt all questions. All questions carry Equal marks

Q1: Answer the following whether ***TRUE*** or ***FALSE*** with justifications

(vii) The ratio between the longest path and the shortest path in a red-black tree is half

(viii) A red-black tree with n internal nodes has height at most log(n)

(ix) The best case running time for the quick-sort when all the elements are same is $O(n^2)$

(x) Amortized analysis determine the worst-case bound on sequence of operations using probability

(xi) In a DAG, the number of distinct paths between two vertices is at most $|V|^2$

(xii) Any sub-path of a shortest path may not always be a shortest path

Q2. Answer the followings related to Dynamic Table:

(c) Differentiate between thrashing and swapping of data in dynamic Tables.

(d) Write the function part of insertion and deletion for Dynamic Table

```
Initialize Table size ___(give the value)____
INSERT(x)
  {Write the insert function here }
DELETE(x)
  {Write the delete function here}
```

Q3. Let the Restricted Red-Black Tree is define to be a standard Red-Black Tree with the added structural constraint that every red node must be the right child of its parent. So, every left child is black. (In comparison with 2-3-4 trees, this indicates that we have no 4-node clusters, and every 3-node cluster is right slanted.) Let T be an arbitrary n-node RRB-tree.

(a) Obtain tight lower and upper bounds on height of T as a function of n.

(b) Show how to perform the dictionary insert operation on T efficiently. Make sure you consider all possible cases in the algorithm. What is its worst-case running time as a function of n?

Q4. Determine the expected running time complexity of the followings:

a)

Solve the recurrence: $T(n) = \begin{cases} 1 & \text{if } n = 1 \\ T(n-1) + n(n-1) & \text{if } n \geq 2 \end{cases}$

b) $T(n) = 2T(\sqrt{n}) + n\log(n)$

Q5. Construct a simple Binary Search Tree (BST) containing:

9 7 5 18 4 35 15 45 37 52

(f) Give the outcome of Inorder, Preorder and Postorder Traversal

(g) Construct then a Red black tree (RB tree) and

(h) Convert the constructed RB Tree into 2-3-4 Tree

(i) Insert the following numbers in the RB Tree 4 and 45

(j) Delete the number 18 from the RB Tree

Department of Computer Science and Engineering, MNIT Jaipur
End Term Examinations, December 2023

Subject: **Computer Vision** Subject Code: **21CST806**
Duration: **2.5 Hrs** Full Marks: **50**
The question paper has two pages. Answer all five questions. All parts of a question must be answered in sequence. Figures at the right margin indicate marks.

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1. (a) Write the importance of texture features. For the following 4×4 image with 4 gray levels, compute the GLCM and normalized GLCM. (Note: Consider the default values of the parameters to compute GLCM) [5]

0	1	0	2
0	2	1	1
3	1	0	0
0	0	2	3

(b) Suppose you don't have sufficient training images to train your deep learning model. What approach you would adopt to overcome the shortage of data. Justify your answer. [2]

(c) Can we use image transform techniques to extract features from images or videos? If your answer is yes, then discuss about one such technique and the steps to be followed. [3]

2. (a) Suppose you design a multilayer perceptron for classification with the following architecture. It has a single hidden layer with the hard threshold activation function. The output layer uses the softmax activation function with cross-entropy loss. What will go wrong if you try to train this network using gradient descent? Justify your answer in terms of the backpropagation rules. [3]

(b) You are given the following 4×4 image. Apply one first order derivative filter to find out the edges in the image. [4]

30	30	90	90	30
30	30	90	90	30
30	30	90	90	30
30	30	90	90	30
30	30	90	90	30

(c) What is clustering based segmentation? Discuss one such approach that is extensively used for image segmentation. [3]

3. (a) Consider a 3 layered feed-forward neural network as shown in Figure 1. Perform forward pass on the network and find error if the target value is 1. Using backpropagation, perform the backward pass and update the weights of different layers. For the 2nd iteration, calculate the error and compare the two errors and comment on the result. Set the activation function in hidden and output neurons as sigmoid, and learning rate as 0.5. Also, consider MSE as the loss function. [7]

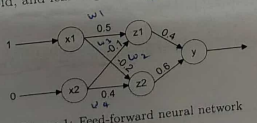

Figure 1: Feed-forward neural network

$w_1 = 0.5$
$w_2 = -0.2$
$w_3 = -0.1$
$w_4 = 0.4$

(b) You are given a dataset containing a set of images with resolution 512×512 pixels and your task is to perform a classification task. Which approach among CNN and traditional feed-forward neural network you would choose to accomplish the task? Justify your answer. [3]

4. (a) You are given the following CNN model to perform classification task. For each layer, compute the number of weights, number of biases and the size of the associated feature maps. [6]

Layer	Activation map dimensions	Number of weights	Number of biases
Input	$224 \times 224 \times 3$	0	0
$(CONV, 7, 32)$			
$(POOL, 2, 2)$			
$(CONV, 5, 64)$			
$(POOL, 3, 2)$			
$(CONV, 3, 128)$			
$(POOL, 2, 2)$			
$(FC, 3)$			

The notation follows the convention:
- $(CONV, F, N)$ denotes a convolutional layer with N filters, each them of size $F \times F$, padding and stride parameters are always 0 and 1 respectively.
- $(POOL, F, S)$ indicates a $F \times F$ pooling layer with stride S.
- (FC, M) stands for a fully-connected layer with M neurons.

(b) What are bottleneck layers in CNN architectures? Why are they used? [2]

(c) What is the name of the method that could reuse the pretrained weights for the task at hand? [2]

5. (a) Given the following image of size 6×6 and filter of size 3×3 (Figure 2): [5]

i. Perform convolution with the given filter at stride 3 and pad 0 (without padding)

ii. Perform average pooling with filter size (2,2) with stride 2

1	1	1	0	0	1
0	1	1	1	0	1
0	0	1	1	1	0
0	0	1	1	0	0
0	1	1	0	0	1
1	0	0	1	1	0

(a) 6×6 image

1	0	1
0	1	0
1	0	1

(b) 3×3 filter

Figure 2: Input image and filter

(b) Why is ReLU is often preferred over sigmoid as an activation function in deep networks? [2]

(c) When do underfitting and overfitting occur in convolutional neural networks? How will you handle it if such problems arise? [3]

********** All the Best **********

Malaviya National Institute of Technology Jaipur
Department of Computer Science and Engineering
Subject: Machine Learning Quiz-1 MM:10

1. What is the effect on the value of $p(x)$ for a Gaussian distributed data when the difference between x and μ increases/decreases?
2. How does variance of the Gaussian distribution affect the shape of the normal (bell) curve?
3. How and why do we normalize the bell curve?
4. Why do we prefer discriminant functions for class membership compared to the posterior probability?
5. If the covariance matrices are all equal for all the classes. What kind of decision boundary will we get?
6. What kind of decision boundary will we get if two classes have same density and one class has a larger prior than the other class?
7. What kind of decision boundary do we get if the two classes have same mean and unequal variance?
8. Derive and interpret the general discriminant function for two d dimensional Gaussian distributed classes. [3]

OR

Example	Attribute			Class
	x_1	x_2	y	
1	3	2	2	A
2	5	6	7	A
3	8	1	5	A
4	2	5	2	B
5	6	3	4	B
6	1	6	3	B

Given the training set with the above six examples, each described by three attributes from a Gaussian distributed data. What is the most probable class for $x = (9, 2, 3)$. (Use Maximum likelihood estimate and independent-attribute assumption).

Department of Computer Science and Engineering, MNIT Jaipur
End Term Examination 2023, M.Tech (CSE/CSIS) 1st Semester

Subject: Advanced Data Structure and Algorithms (CST 501/CST521)
Date and time: 4 Dec. 2018, (10:00am - 12:30pm)
Note: Attempt any SEVEN questions. Question No 1 is compulsory. All remaining questions carry equal marks
Max Marks: 40. (Distribution: Q1 2x5, Q2-5 to Q9-5)

Q1. Answer whether ***TRUE*** or ***FALSE*** with justifications

(1) In dynamic programming, it is necessary to retain all intermediate results through the entire computation

(2) The following graph is a Hamiltonian graph

(3) A graph G is Eulerian if and only if it is connected and every vertex of G has even number of degree

(4) Las Vegas becomes a Monte Carlo randomized algorithm on the zero probability error

(5) The Weighted Vertex Cover Problem (WVCP) is a ρ-approximation algorithm where $\rho=\frac{1}{2}$ and $W(C) \leq \frac{1}{2} W(COPT)$

Q2. Given an undirected graph G(V,E) in Figure-1 with vertex weights assigned to each vertex. Describe the approximation algorithm and apply in the given graph to minimize the weight of vertex cover C that covers all edges, i.e., $\forall (u,v) \in E$, $u \in C$ or $v \in C$ (or both).

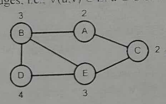

Figure 1

Q3. Given a non-weighted graphs in Figure 2. Apply an iterative bisection partitioning algorithm (KL Algorithm) for the balanced (of equal size) partition and determine the minimum cut size.

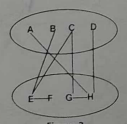

Figure 2

Q4. The Set Cover (SC) generalizes Vertex Cover (VC). In VC, elements (clients) are edges, and sets (servers) correspond to vertices. The set corresponding to a vertex v is the set of edges incident to v. Describe the Approx WSCP by Pricing Method and minimize the weight of set cover C for the set $X = \{x_1, x_2, \ldots, x_n\}$ of 8 elements for the family $F = \{S_1, S_2, \ldots, S_m\}$ of 8 subsets of X, and w(F): weights w(S)>0, for each S∈F as shown in Figure 3.

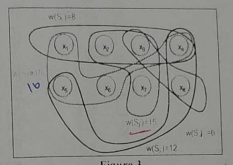

Figure 3

Q5. What is the recurrence solution for the Length Common Subsequence (LCS). Given the two sequences

$X = B, D, C, A, B, A$
$Y = A, B, C, B, D, A$

Find a maximum Length Common Subsequence (LCS) of X and Y.

Q6. Given the digital circuit shown in Figure 2. A derive the Boolean formula is in conjunctive normal form (CNF) and determine whether the circuit is satisfiable or not.

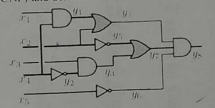

Figure 4

Q7. Given a chain of matrices $(A1, A2, \ldots, A4)$, where Ai has dimensions $pi - 1$ x pi, fully parenthesize the product $A1 \ldots A2 \ldots An$ in a way that minimizes the number of scalar multiplications. Give the recursive solution for minimizing the cost of parenthesizing the matrix $Ai..Ai + 1 \ldots Aj$ and compute **A1 x A2 x A3 x A4** where. **A1: 10 x 45 ; A2: 45 x 25 ; A3: 25 x 50 ; A4: 50 x 10**

Q8. Given a Layered 0 to 6 in graph G where, s = starting vertex at layer 0, t = terminal vertex at layer 6. Each edge (u,v) has assigned some weight w(u,v) in graph G.

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

End Term Examination, Autumn Semester 2023-24

I Semester M. Tech Computer Science and Engineering
I Semester M. Tech Computer Science and Information Security

Marks: 50 **21CST833 Special Topics in Computing** Time: 150 mins

Answer Any 5 (Five) Questions

1. Discuss the types of NO SQL Databases based on the CAP Theorem (4)

   Describe the MapReduce mechanism. Describe the paradigm change in Spark in comparison with MapReduce. (6)

2. Explain the process of digital signature generation and verification in Bitcoin. Which property of elliptic curve cryptography ensures its security? (5)

   How can you control the way in which UTXOs are locked and spent? How can you create and validate a P2SH multi-signature transaction? (5)

3. Why is blockchain considered immutable? Explain with a diagram the components of a Bitcoin block. (5)

   Why is mining required in blockchains? Draw the flow diagram explaining various steps involved in Bitcoin mining. How is mining difficulty adjusted? (5)

4. Define Tor and explain the original objectives. Explain connecting to Tor and compare the same with HTTPS and VPNs with neat diagrams. (5)

   Explain Tor's Packet Request and response process with a diagram. Compare the roles of Introduction and Rendezvous Points in this process. (5)

5. Explain different layers of web and compare them. Weigh in the Positive and Negative aspects of the Dark web. (5)

   Explain the role of various nodes of Tor Network with a neat Diagram. Define Heartbeat and illustrate its role in Tor Network. (5)

6. Compare Classical Logic and Quantum Logic (4)

   Represent |0> and |1> on bloch sphere and discuss another point on the sphere (2)

   Discuss Superposition and Entanglement (4)

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Mid Term Examination, Autumn Semester 2023-24

I Semester M. Tech Computer Science and Engineering
I Semester M. Tech Computer Science and Information Security

Marks: 30 **21CST833 Special Topics in Computing** Time: 90 mins

Answer All Questions

1. Discuss the types of File Systems used in Storage Virtualization and compare the underlying protocols.
   Describe the evolution in hardware to handle the types of storage traffic.

2. Explain the different mechanisms of Virtualization and compare them. (3)
   Compare Hyper-V, vSphere, KVM and Xen (3)

3. Distinguish between Virtualization and Containerization. (3)
   Imagine a Cloud of Containers built from KVM, OpenStack, Kubernetes, Mesos, Magnum, Docker and any other related tool / software you are aware of. Draw a neat diagram to explain the layers where each of these software will fit. Critique the pros and cons of such a system. (3)

4. Explain the architecture of OpenStack for 8 nodes with a neat diagram. (3)
   Describe the various services (at least 6) in OpenStack and list them in the above diagram as well. (3)

5. Explain the core principles of Hadoop (2)
   Discuss the Hadoop Ecosystem with a neat diagram (4)

6. Discuss the architecture of GFS and the assumptions on which GFS was built (3)
   Explain the role of Secondary Name Node with a neat diagram in Hadoop (3)