Roll No. | | | | | | | | | | | | | Total No. of Pages : 02

Total No. of Questions : 08

M.Tech. (CSE) (2018 Batch) (Sem.–1)

ADVANCED DATA STRUCTURES

Subject Code : MTCS-102-18

M.Code : 75154

Time : 3 Hrs. **Max. Marks : 60**

INSTRUCTIONS TO CANDIDATES :

1. Attempt any FIVE questions out of EIGHT questions.
2. Each question carries TWELVE marks.

1. (a) A call centre uses a hash table with open addressing to store customer orders taken during its working hours of 7am to 11pm every day of the year. Orders are kept in the hash table for 5 years and then deleted. It currently has about 5 million entries, and handles about 1 million transactions per year (i.e. between 2 and 3 a minute).

   What size hash table would you suggest ?

   (b) Suppose someone suggested copying the entries in the hash table into a new hash table, and it takes 2 milliseconds to copy one item. Would that be a sensible thing to do?

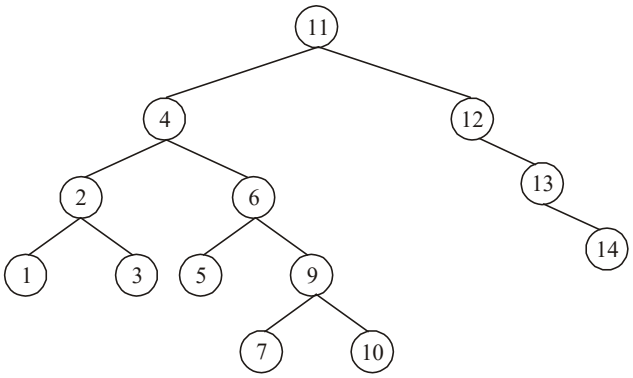
   (c) The performance of the hash table has degraded. Why might this have happened?

2. (a) How many different orderings of the four numbers {1, 2, 3, 4} are there?

   (b) By considering all those possible orderings, draw all possible binary search trees of size four with nodes labeled by the four numbers {1, 2, 3, 4}. After discarding any duplicate trees, how many different binary search trees of size four are there?

   (c) For each different tree, state its height, how many leaf nodes it has.

3. Consider the following splay tree :



(a) Perform a delete for the key 3 under the assumption that this is a bottom-up splay tree. Show each step.

(b) Perform a split from the tree of Figure 1 (not the resulting tree of part 1)) for the key 8 under the assumption that this is a top-down splay tree. Show each step.

4. (a) Describe an algorithm select(S,k) to find the k-th sized element in a skip list S with n elements. You can add a field to each node of S. The average time of the algorithm should be O(logn). Explain with an example .

(b) Suggest a way to use a skip list to contain numbers in the range [7..n] (n is a not constant) and supports the following query :

Given a pointer to element x, x.key=i, and j < i, find the element y, such that y.key= j in O(log k) expected time, where k is the distance between x and y.

Explain with an example.

5. **Longest Common Subsequences.** The Longest Common Subsequence (LCS) of two strings: $S_a = s_{a1}\ s_{a2} \ldots s_{am}$ and $S_b = s_{b1}\ s_{b2} \ldots s_{bn}$ is a string $S_c = LCS(S_a, S_b) = s_{c1}\ s_{c2} \ldots s_{cq}$ such that S_c is a subsequence of S_a and S_c is a subsequence of S_b, and for any other common subsequence S_c of S_a and S_b, length(S_c) >= length(S_c).

It is possible to compute the length of an LCS using Dynamic Programming.

(a) Give a recurrence equation for computing M(Prefix(S_a, i), Prefix(S_b, j)) which is defined as the length of a longest common subsequence of Prefix(S_a, i) and Prefix(S_b, j). Here Prefix(S, k) is defined as the string consisting of the first k characters of S.

(b) Draw the 2D array of values for M(Prefix(S_a, i), Prefix(S_b, j)) for the following pair of strings.

S_a = A L K W A R I Z M I

S_b = A L G O R I T H M

(c) Draw a backtrace on the array that shows how to recover LCS(S_a,S_b) from the M array. Circle the entries of the array M that correspond to one particular LCS.

6. Explain in detail k-D trees along with example.

7. Explain recent trends in Hashing for efficiently solving the new evolving problems.

8. (a) Write the Huffman coding Algorithm.

(b) Suppose we want to store messages made up of 4 characters a, b, c, d with frequencies 60, 5, 30, 5 (percents) respectively. What are the fixed-length codes and prefix-free codes that use the least space?