CS251 - Data Structures and Algorithms
Fall 2024

Question 1

(Hashing) Let T be an empty hash table of length $m = 12$ with $h(k) = k \mod 12$ for $k \in \mathbb{Z}^+$. T uses linear probing as a collision management technique. The following is the content of T after inserting six values.

0	1	2	3	4	5	6	7	8	9	10	11
				16	17	28	18	8	31		

(a) Write an order of insertion for these six values such that the state of T is the one displayed above.

(b) Can another insertion order give the same state? Explain your answer.

(c) What is the load factor of T? Is there any issue occurring in T?

(d) Illustrate T if the collision management technique used was chaining.

Question 2

(Binary search tree)

(1) How many different shapes of a binary search tree are possible when 3 elements are inserted into?

(2) What is the asymptotic performance of inserting n items with keys sorted in a descending order into an initially empty binary search tree?

(3) Is the operation of deletion "commutative" in the sense that deleting x and then y from a binary search tree leaves the same tree as deleting y and then x? Argue why it is or give a counterexample.

Question 3

(Binary search tree)

How to find the minimum distance between any two different nodes in a BST efficiently?

Question 4

(2-3 tree)

(1) How many 2–3 trees exist storing the keys $\{1, 2, 3, 4, 5\}$?

(2) Insert $\{15, 21, 7, 24, 0, 26, 3, 28, 29\}$ (in the given order) into an initially empty 2-3 tree.

(3) Delete element 7 in the final 2-3 tree obtained in question (2).