Skiplist Efficiency & Extension

- Efficiency/time complexities for the topic are considered. Note that these discussions are not exhaustive or representative of the types of questions that may be found on the exams.
- Practice problems are given to test your understanding of the topic. These problems are not for a grade, but promote a deeper level of understanding of the topic. Unless otherwise specified, assume you are using *n* data/objects/elements in the data structure or algorithm.
- We look at the worst/average/best case of Big O; however, do not expect all three cases to be explored extensively.
- Feel free to discuss these problems in recitation or during office hours at the TA Help Desk.

Efficiency of Skiplists

A Skiplist is a data structure that stores an ordered sequence of n elements on levels. Levels are comprised of linked lists. The levels are connected for a grid like structure. What level an element resides on is determined by a randomized algorithm. The goal of Skiplists is provide an easily searched linked list like structure.

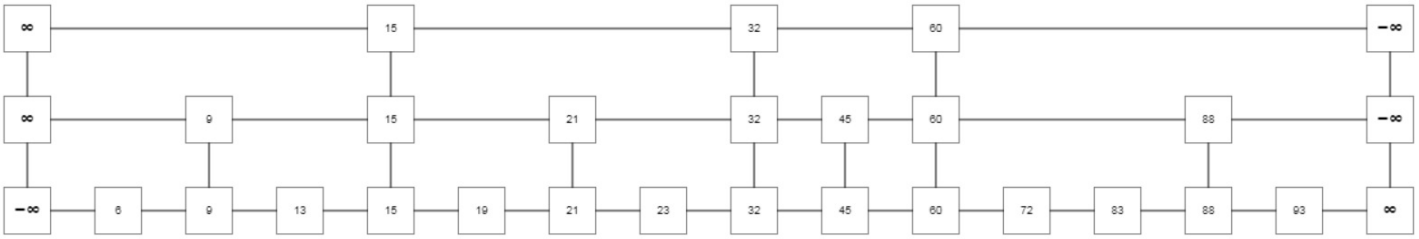
All *n* skiplist elements reside in the bottom most layer, Level 0. Based on probability, the second layer, Level 1, will contain approximately half of all elements on Level 0, (n/2). Level 2 will contain approximately half of all elements on Level 1, (n/4). And so on. To determine the space complexity, one would use a geometric series n + n/2 + n/4 + n/8 ... ➔ approaches 1, when n approaches infinity. This results in an average case of space complexity to be O(n). In the worst case, however, every level is completely filled, so the space complexity depends on the maximum number of levels (assuming there is a cap), O(n log n).

Skiplists are designed for searches, and have the basic operations of** insert, delete, search, **and** size**.

1) ***What information does an Skiplist node need to store beyond the basic data information?***
   _____
2) ***Is the time complexity of storing this extra information constant?***
   _____
3) ***Will the extra node information impact the overall time complexity?***
   _____
4) ***What is the cost to perform an insertion on every level of the skiplist, and is it always this cost?***
   _____
5) ***What is the average & worst time complexity of searching for a data value in a Skiplist? _____***
6) ***What is the average & worst time complexity of adding a data value to a Skiplist? _____***
7) ***What is the average & worst time complexity of removing a data value to an Skiplist? _____***
8) ***What is the best time complexity to add, remove or search for a data value in an Skiplist?***
   _____

9) ***What is the cost to find the height of an Skiplist? _____***

Given the following Skiplist



10) ***Label the levels in the Skiplist, and determine the size?***

11) ***How many elements are stored on levels 0, 1, 2, etc...***

12) ***Add 40 with only a T, then 75 with HHHT.***

13) ***Remove 13, then 18.***

Extension
Conceptual

Describe how you add a node to a Skiplist when the coin toss determines that you have to also add a new level to the Skiplist.

Explain the need for having dummy nodes in a Skiplist.

Diagramming

For these questions, draw a diagram that clearly shows each step being performed for the following actions in an Skiplist.

1) ***Add 359, 753, 588, 252, 93, 340, 12, 698, 844, 773***
   Using the following coin toss: T HHT HHHHT T HT T T HT HHT T

2) ***Remove 340, 93, 753***