Lab : Heap Sort

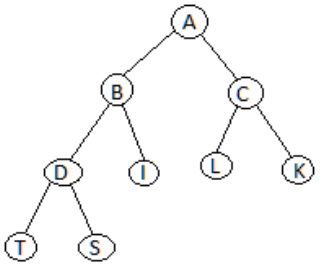
CLO:

02,03,04

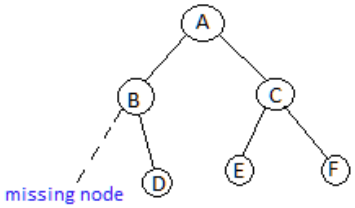
Heap Sort Data Structure:

Heap sort is a comparison-based sorting technique based on Binary Heap data structure. It is similar to selection sort where we first find the maximum element and place the maximum element at the end. We repeat the same process for remaining element.

Binary Heap: Let us first define a Complete Binary Tree. A complete binary tree is a binary tree in which every level, except possibly the last, is completely filled, and all nodes are as far left as possible A Binary Heap is a Complete Binary Tree where items are stored in a special order such that value in a parent node is greater(or smaller) than the values in its two children nodes. The former is called as max heap and the latter is called min heap. The heap can be represented by binary tree or array.



Complete Binary Tree



In-Complete Binary Tree

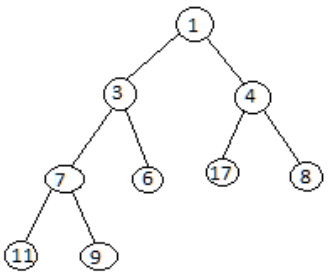
Heaps can be used in sorting an array. In max-heaps, maximum element will always be at the root. Heap Sort uses this property of heap to sort the array. Consider an array which is to be sorted using Heap Sort.

1. Initially build a max heap of elements in Arr.
2. The root element, that is Arr[1], will contain maximum element of Arr. After that, swap this element with the last element of Arr and heapify the max heap excluding the last element which is already in its correct position and then decrease the length of heap by one.
3. Repeat the step 2, until all the elements are in their correct position.

Heap Property: All nodes are either greater than or equal to or less than or equal to each of its children.

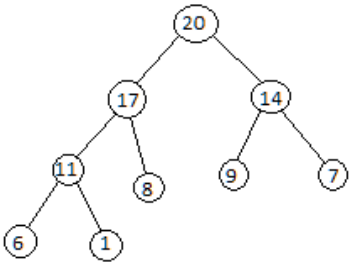
Types of Heap:

Max-Heap: If the parent nodes are greater than their child nodes, heap is called a Max-Heap,
Min-Heap: If the parent nodes are smaller than their child nodes, heap is called Min-Heap.



Min-Heap

In min-heap, first element is the smallest. So when we want to sort a list in ascending order, we create a Min-heap from that list, and picks the first element, as it is the smallest, then we repeat the process with remaining elements.



Max-Heap

In max-heap, the first element is the largest, hence it is used when we need to sort a list in descending order.

Applications of Heap Data Structure

- **Priority Queues:** Priority queues can be efficiently implemented using Binary Heap because it supports insert(), delete() and extractmax(), decreaseKey() operations in O(logn) time. Binomoial Heap and Fibonacci Heap are variations of Binary Heap. These variations perform union also in O(logn) time which is a O(n) operation in Binary Heap. Heap Implemented priority queues are used in Graph algorithms like Prim's Algorithm and Dijkstra's algorithm.
- **Order statistics:** The Heap data structure can be used to efficiently find the kth smallest (or largest) element in an array.

Lab Task:

Implement heap sort algorithm the following function on it:

- Heapify()
- BuildHeap()
- HeapSort()
- Display()