DSA through C++

# Heap

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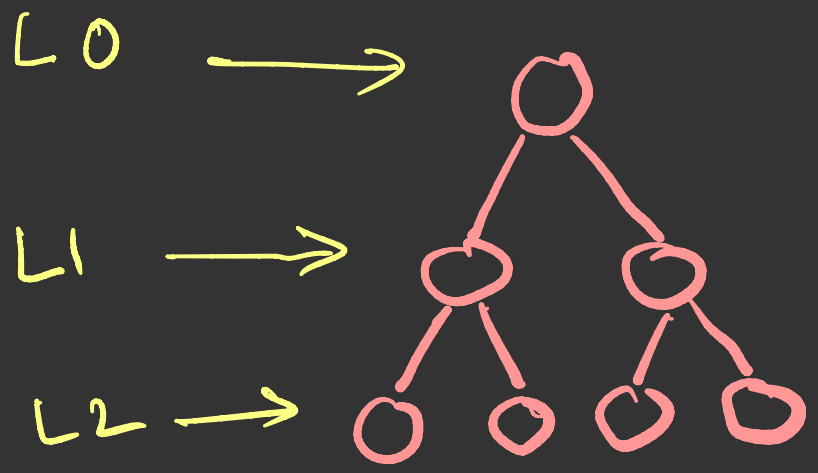
# Agenda

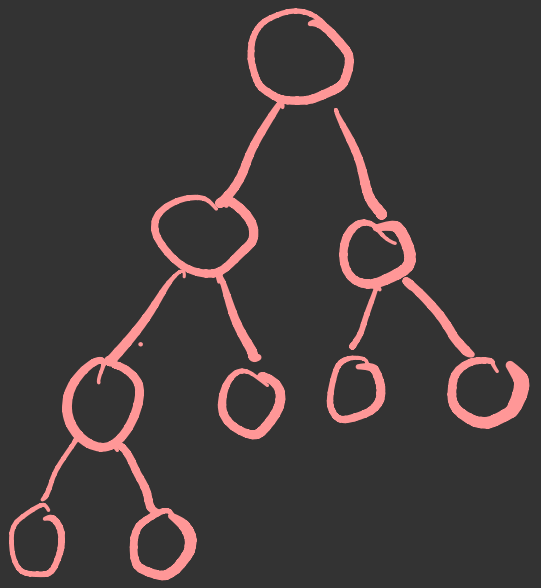
1. Complete Binary Tree
2. Almost Complete Binary Tree
3. Heap
4. Insertion in heap
5. Deletion in heap
6. Heap Sort

# Complete Binary Tree




All levels must be completely filled.

# Almost Complete Binary Tree



All level must be completely filled except possibly the last level and all the nodes in the last level must be left aligned

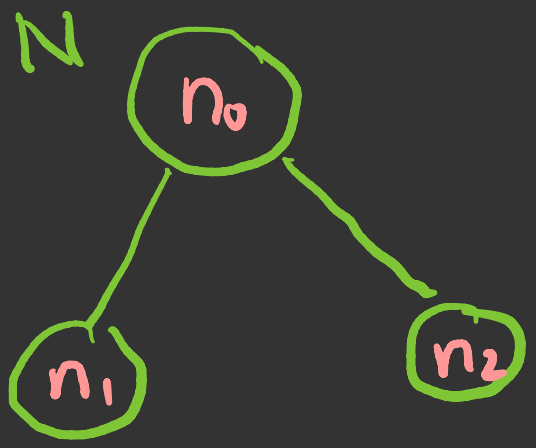
# Heap

- Heap is a data structure
- Heap is used in a sorting algorithm known as heap sort
- Heap are of two types
  - Max Heap (default)
  - Min Heap

# Heap Properties

The value at node N is greater than or equal to value at each children of node N

Heap must be an almost complete binary tree.



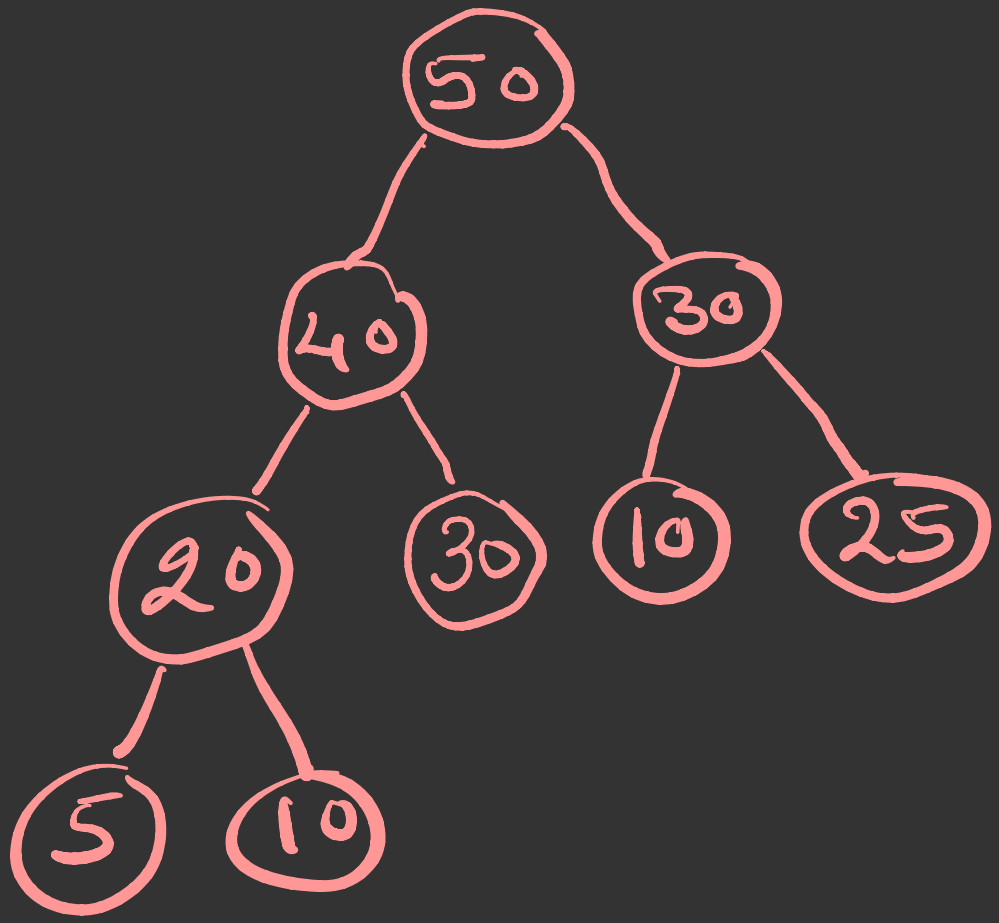

$n_0 \geq n_1$ and $n_0 \geq n_2$

This heap is max heap

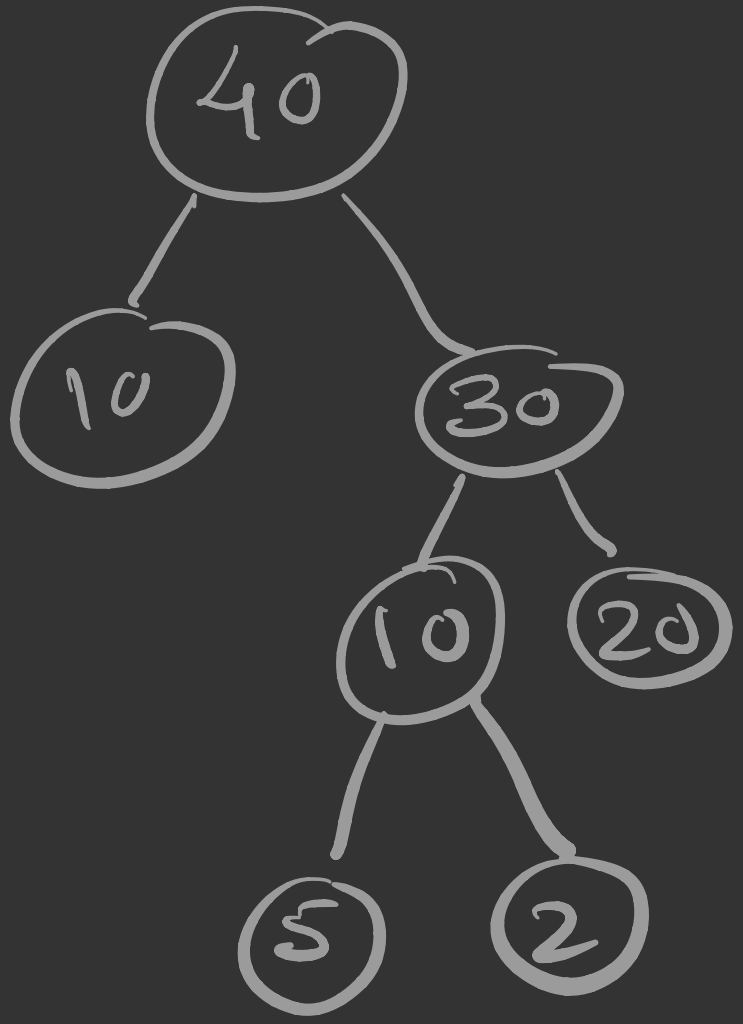
For min heap

$n_0 \leq n_1$ and $n_0 \leq n_2$

# Example



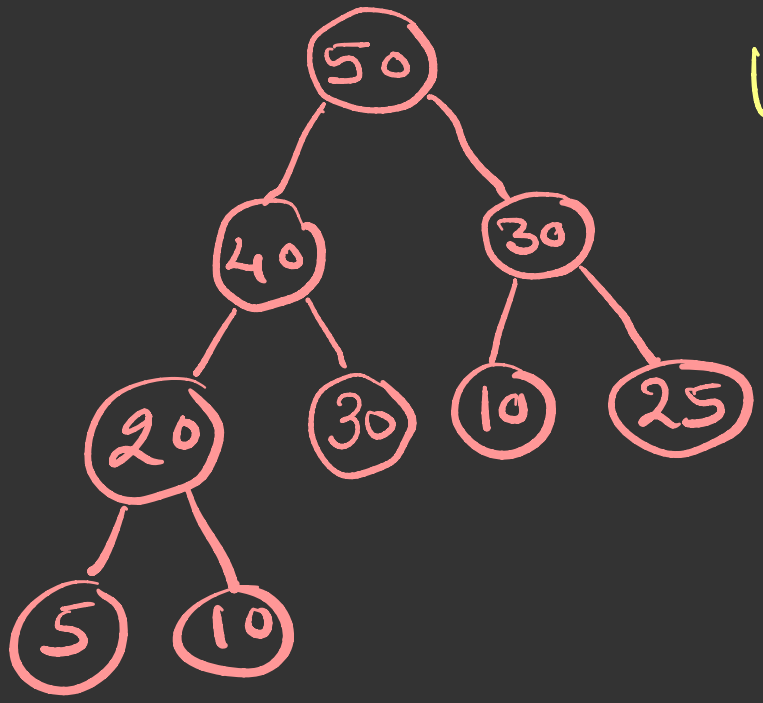

Max-heap




Not a heap

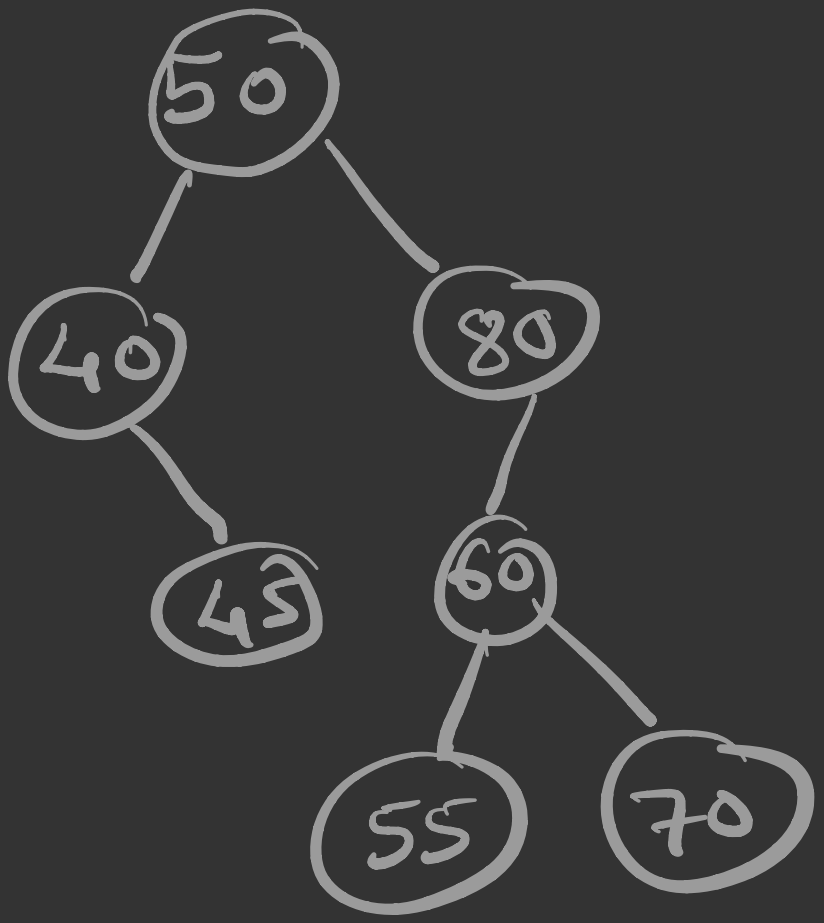
# Representation of Heap

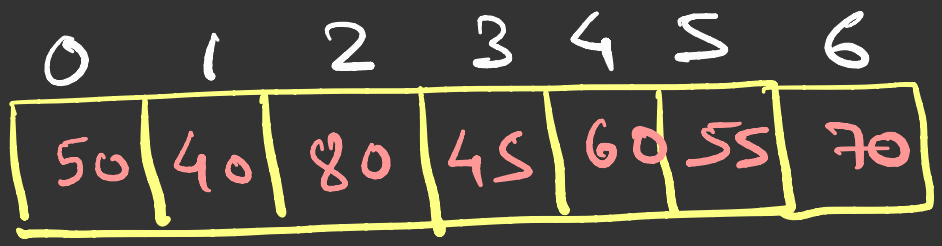
Unless otherwise stated, heap is maintained in memory by a linear array.

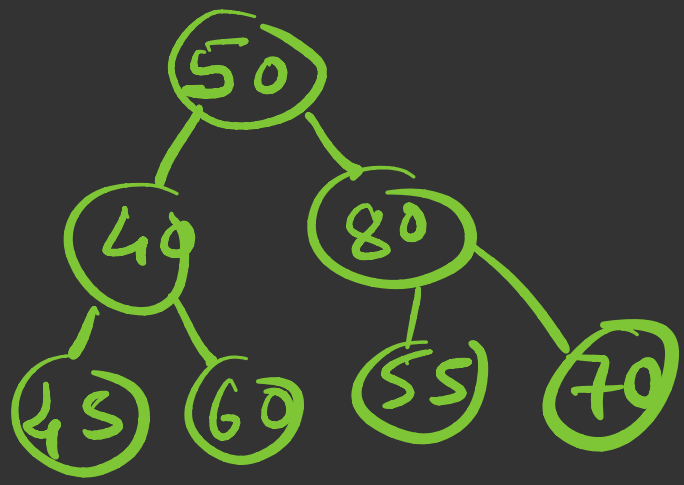



H

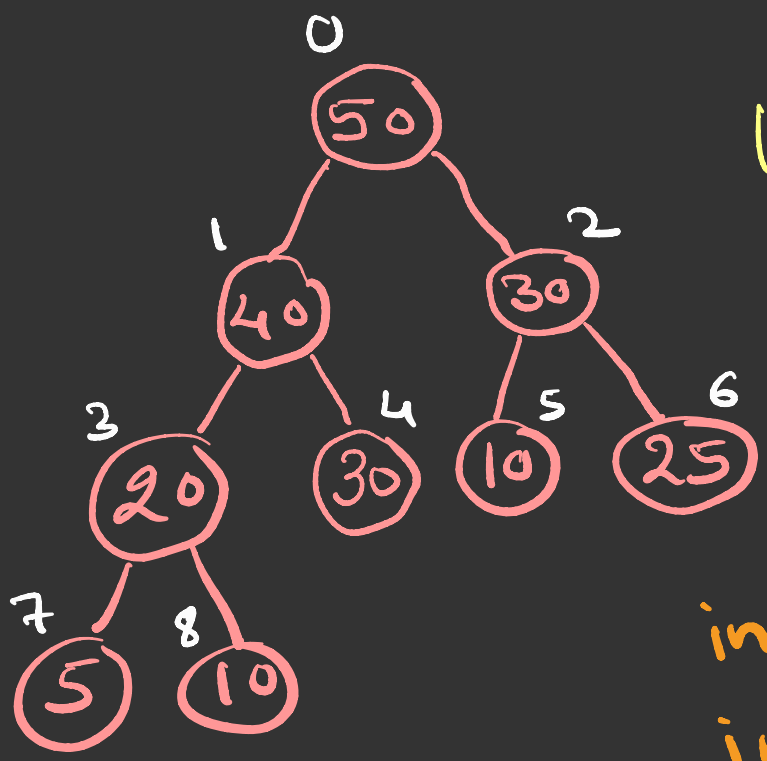
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| 50 | 40 | 30 | 20 | 30 | 10 | 25 | 5 | 10 |


50
40
80
45
60
55
70


0 1 2 3 4 5 6
50 40 80 45 60 55 70


50
40
80
45
60
55
70

# How to find parent or child node?




H

| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| 50 | 40 | 30 | 20 | 30 | 10 | 25 | 5 | 10 |

How to find index of child nodes?

index is index of node N

index of left child = 2 * index + 1

index of right child = 2 * index + 2

How to find index of parent node?

index of node N = index

index of Parent node of N = $\frac{(index - 1)}{2}$

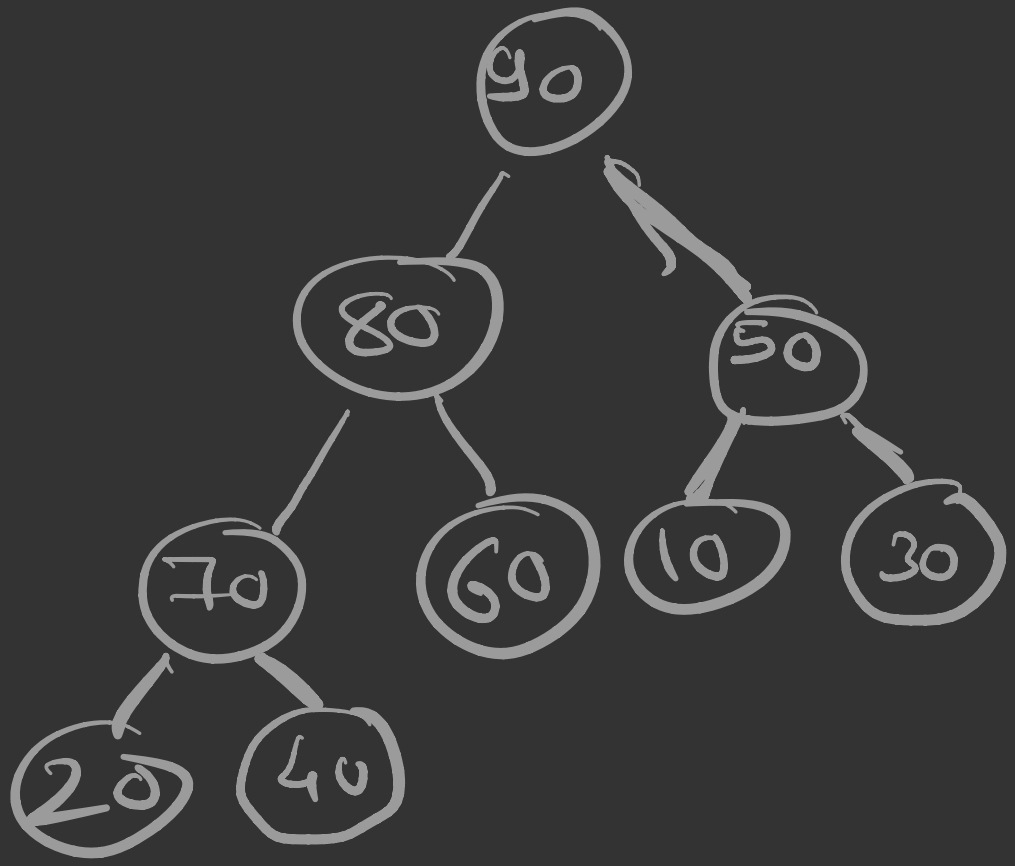
# Insertion

| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| 40 | 70 | 10 | 90 | 60 | 30 | 50 | 20 | 80 |

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| H | 90 | 80 | 50 | 70 | 60 | 10 | 30 | 20 | 40 |

HeapSize = 9

temp 



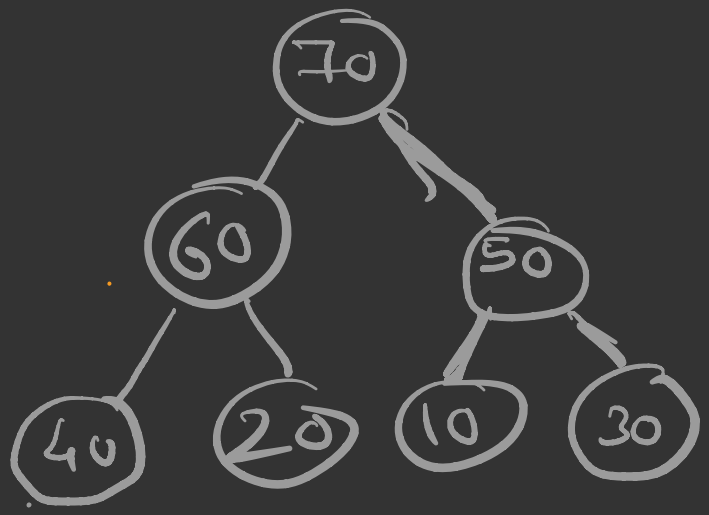
# Deletion

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| H | 70 | 60 | 50 | 40 | 20 | 10 | 30 | | |

HeapSize = 9 8 7

90

80




temp

# Heap Sort

Delete values from the heap (max-heap) and store them in an array from right to left. As a result, at the end of deleting all the elements of heap, array becomes sorted.

Heap can be used to implement priority Queue.