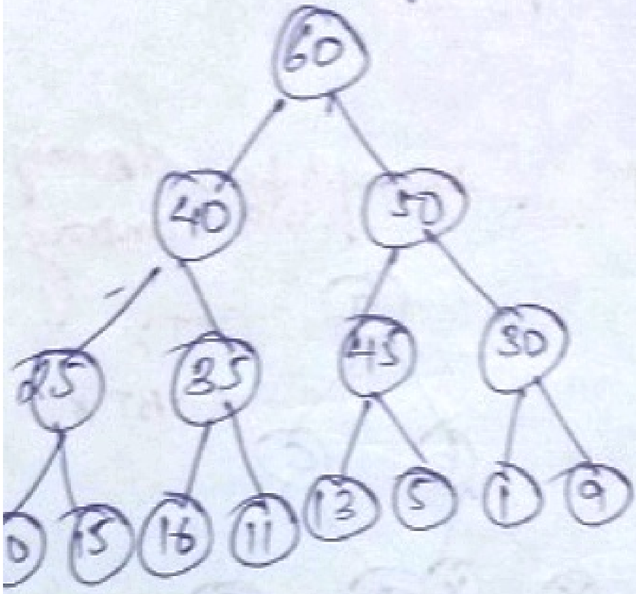
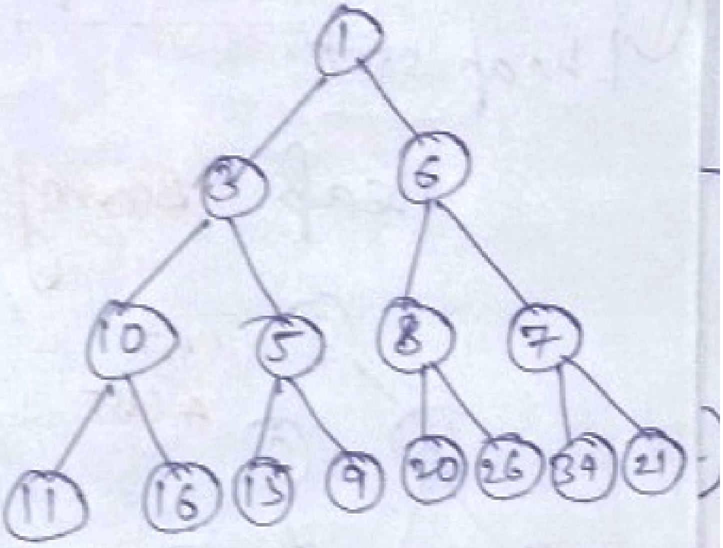
Max heap



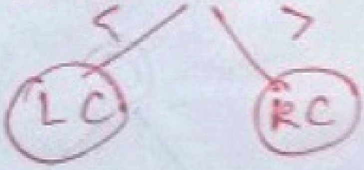
min heap



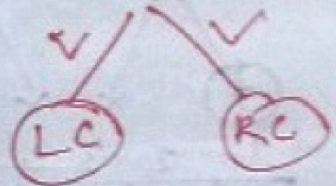
- Almost binary tree
- complete "

BT Vs HT

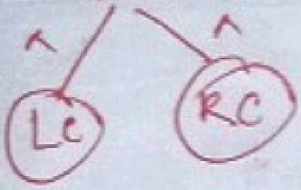
- ~~left child~~ BT



HT→ Max

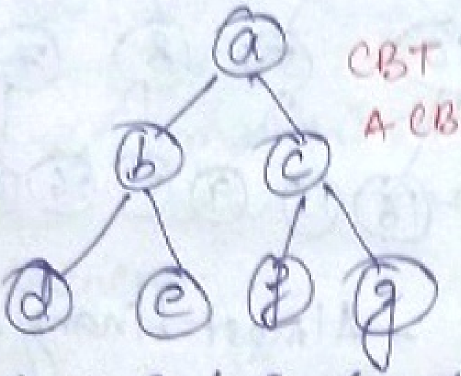


min



Introduction to Heap | Heap Tree with examples | Heap sort.

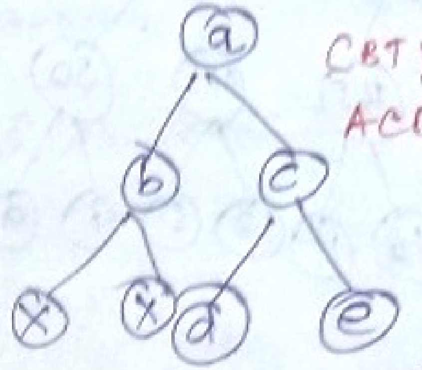
Heap (Binary) - many types also < ternary, n-ary



CBT
A CBT

1	2	3	4	5	6	7
a	b	c	d	e	f	g

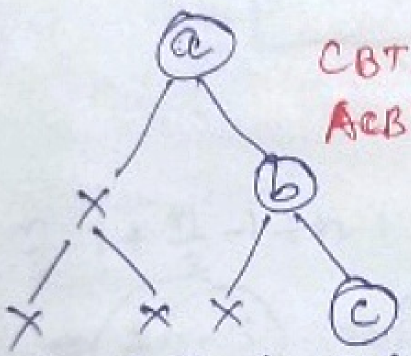
✓



CBT ✗
ACBT ✗

1	2	3	4	5	6	7
a	b	c	-	-	d	e

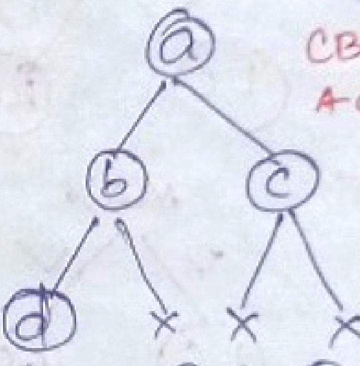
✗



CBT ✗
ACBT ✗

1	2	3	4	5	6	7
a	-	b	-	-	-	c

✗



CBT ✗
ACBT ✓

1	2	3	4	5	6	7
a	b	c	d	-	-	-

✓

index = i

$LC(i) = 2 \times i$ 2 → 4, 7 → 14 // left children

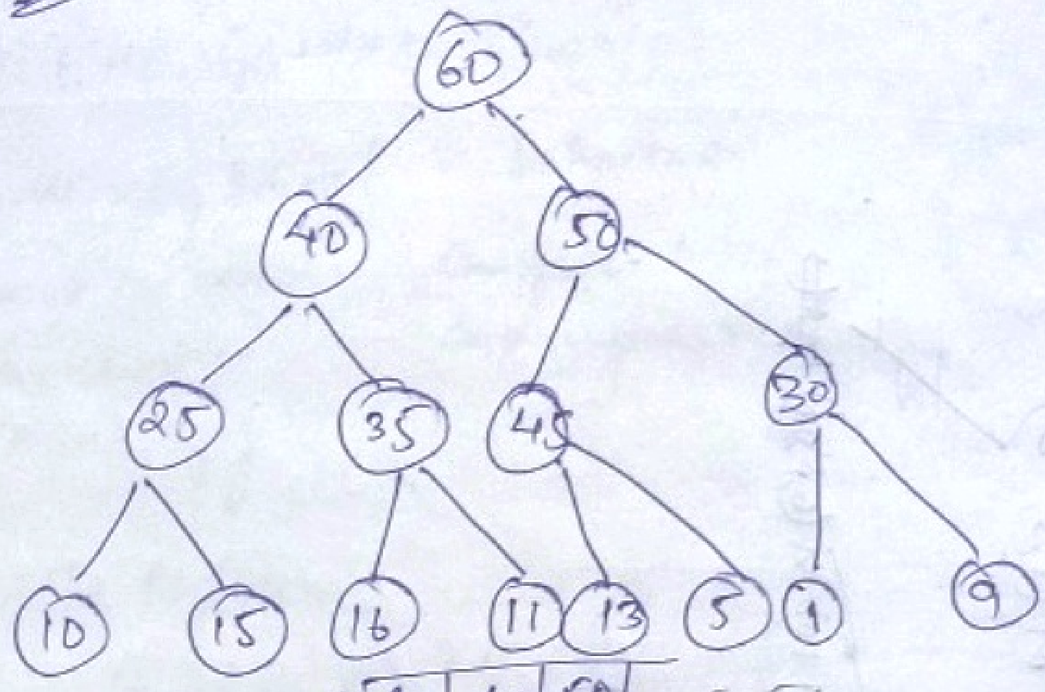
$RC(i) = 2 \times i + 1$ 5, 15 // Right children

$P(i) = \lfloor i/2 \rfloor$ $\lfloor 7/2 \rfloor = 3$

BH ⇒ BT < CBT (complete binary tree), ACBT (Almost binary tree)

(2) Contd:

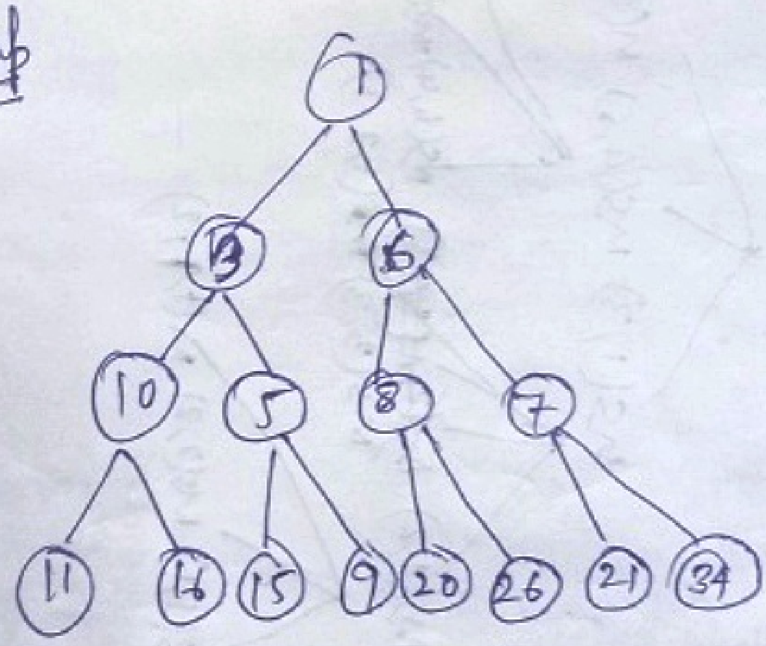
Max heap



60	40	50	...

max element find = O(1)

min heap



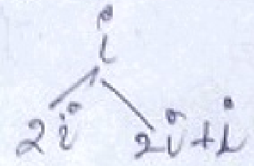
1	3	6	. ...

Min element find = O(1)

Q. 1) 23, 17, 14, 6, 13, 10, 1, 5, 7, 12 ✗

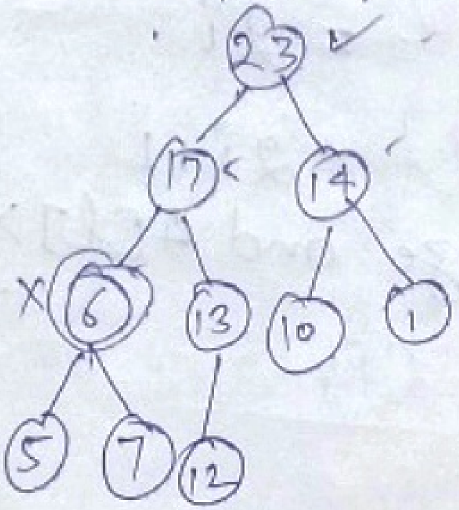
2) 25, 12, 16, 13, 10, 8, 14 ✗

3) 10, 9, 8, 7, 6, 5, 4, 3, 2, 1 ✓

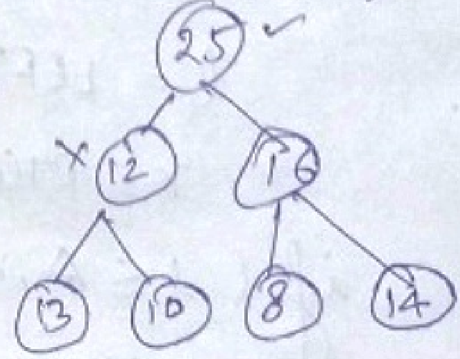


Max heap properties follow above 1) to 3)

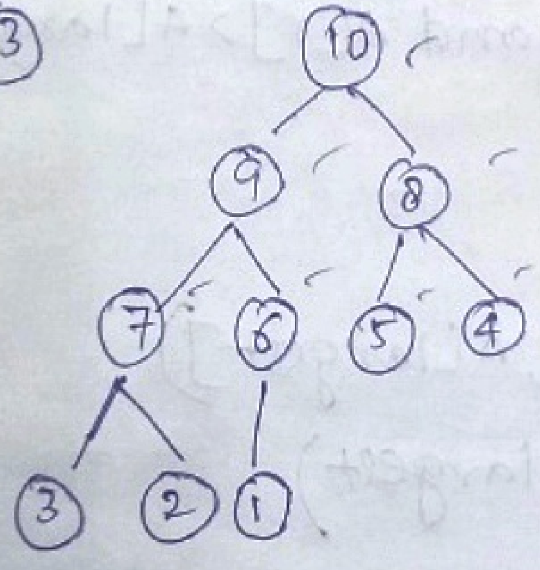
1

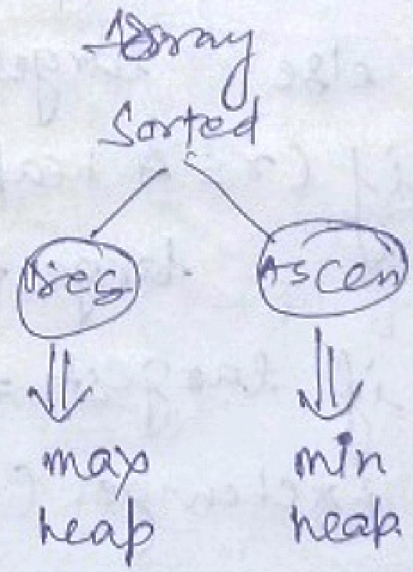


2



3

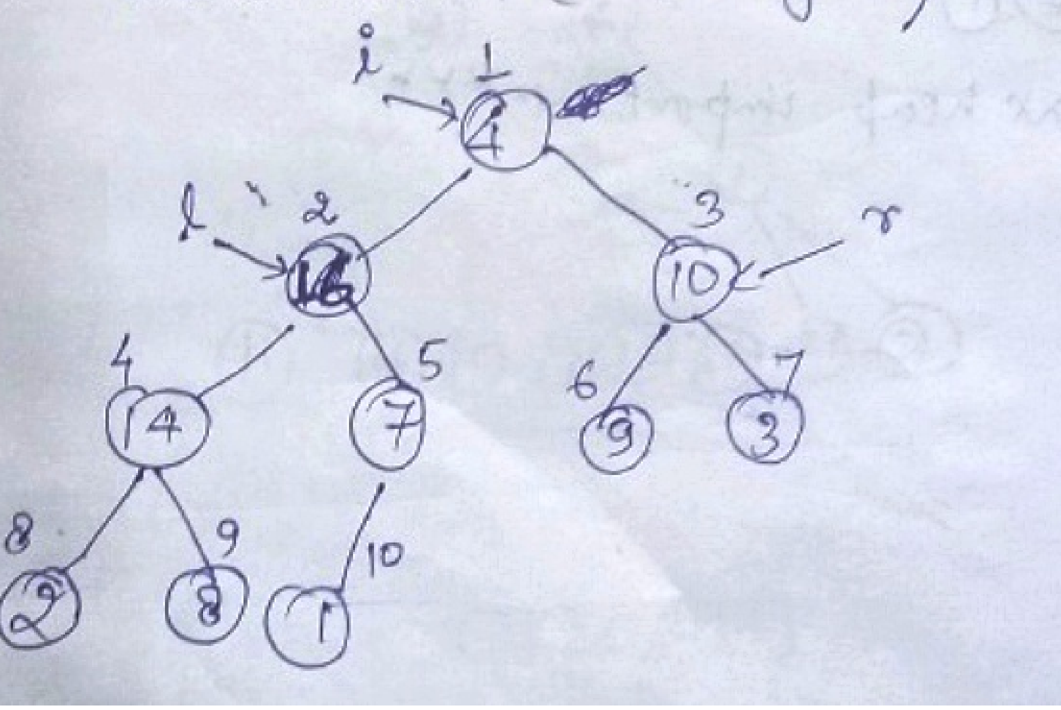


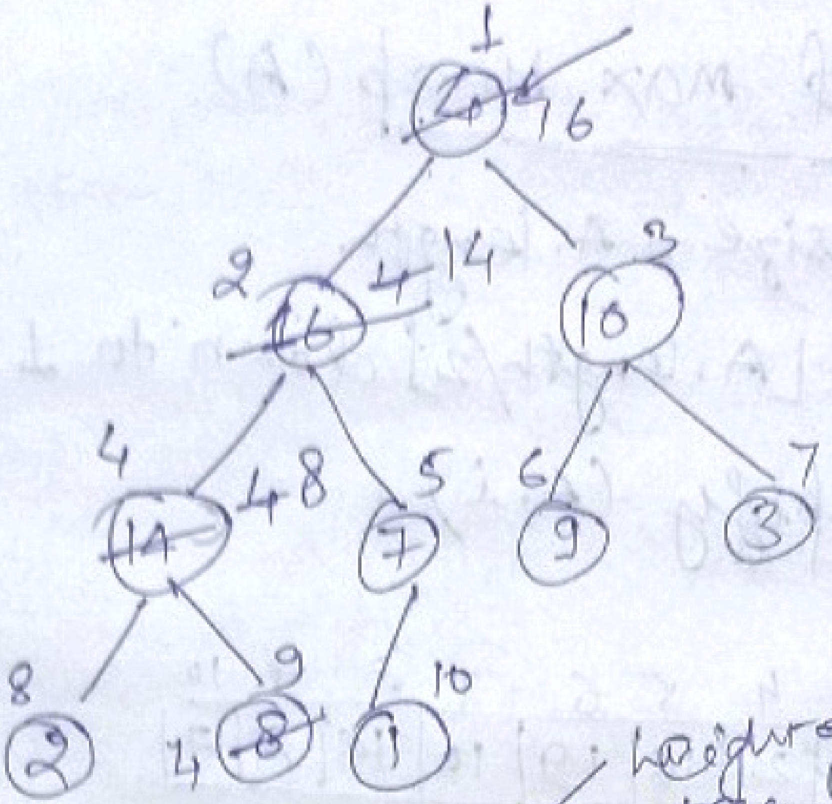


Max heap important ***

Max Heapify

```
MAX-HEAPIFY (A, i)
    l = LEFT(i)          = 2i
    r = RIGHT(i)         = 2i+1
    if ( l ≤ A.heapsize and A[l] > A[i])
        largest = l
    else largest = i
    if (r ≤ A.heapsize and A[r] > A[largest])
        largest = r
    if largest ≠ i
    Exchange (A[i], A[largest])
    MAX-HEAPIFY (A, largest)
```





height of tree

$$= 2 \; \log n + \log n$$

comparison.

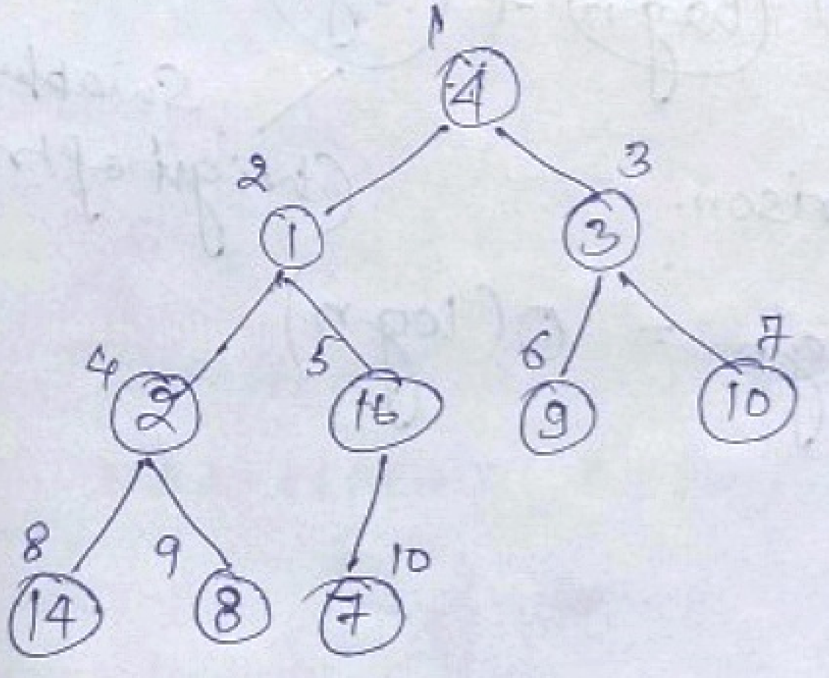
Swapping oper (height of tree)

$$= 3 \log n = O(\log n)$$

Build max Heap (A)

1. A.heapsize = A.length
2. for $i = \lfloor A.length/2 \rfloor$ down to 1
3. Max Heapify (A, i)

	1	2	3	4	5	6	7	8	9	10
A	4	1	3	2	16	19	10	14	8	7



$\underbrace{1 \text{ to } \left\lfloor \frac{n}{2} \right\rfloor}_{\text{internal node}}$, $\underbrace{\left\lfloor \frac{n}{2} \right\rfloor + 1 \text{ to } n}_{\text{leaf node}}$