CS & IT ENGINEERING

Algorithm

Miscellaneous

Lecture No. 1

By- Aditya sir

Recap of Previous Lecture

Topic

Topic

Topic

Graph Traversals

- DFS
- BFS
- Applications

Topics to be Covered

- Topic
- Topic
- Topic

Heaps

About Aditya Jain sir

1. Appeared for GATE during BTech and secured AIR 60 in GATE in very first attempt - City topper
2. Represented college as the first Google DSC Ambassador.
3. The only student from the batch to secure an internship at Amazon. (9+ CGPA)
4. Had offer from IIT Bombay and IISc Bangalore to join the Masters program
5. Joined IIT Bombay for my 2 year Masters program, specialization in Data Science
6. Published multiple research papers in well known conferences along with the team
7. Received the prestigious excellence in Research award from IIT Bombay for my Masters thesis
8. Completed my Masters with an overall GPA of 9.36/10
9. Joined Dream11 as a Data Scientist
10. Have mentored 12,000+ students & working professions in field of Data Science and Analytics
11. Have been mentoring & teaching GATE aspirants to secure a great rank in limited time
12. Have got around 27.5K followers on Linkedin where I share my insights and guide students and professionals.

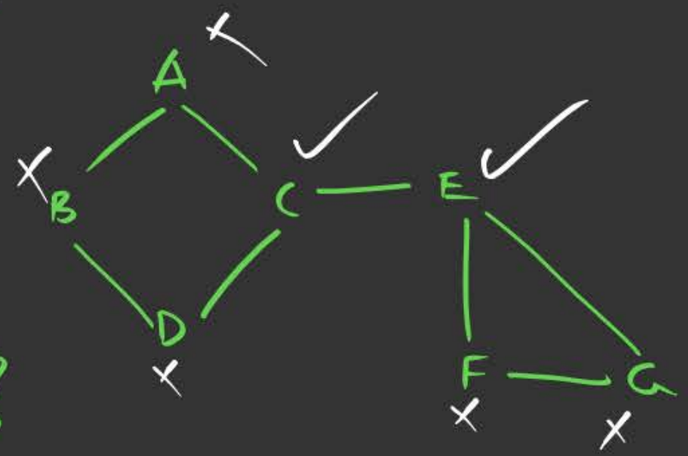
Telegram Link for Aditya Jain sir: https://t.me/AdityaSir_PW

HW

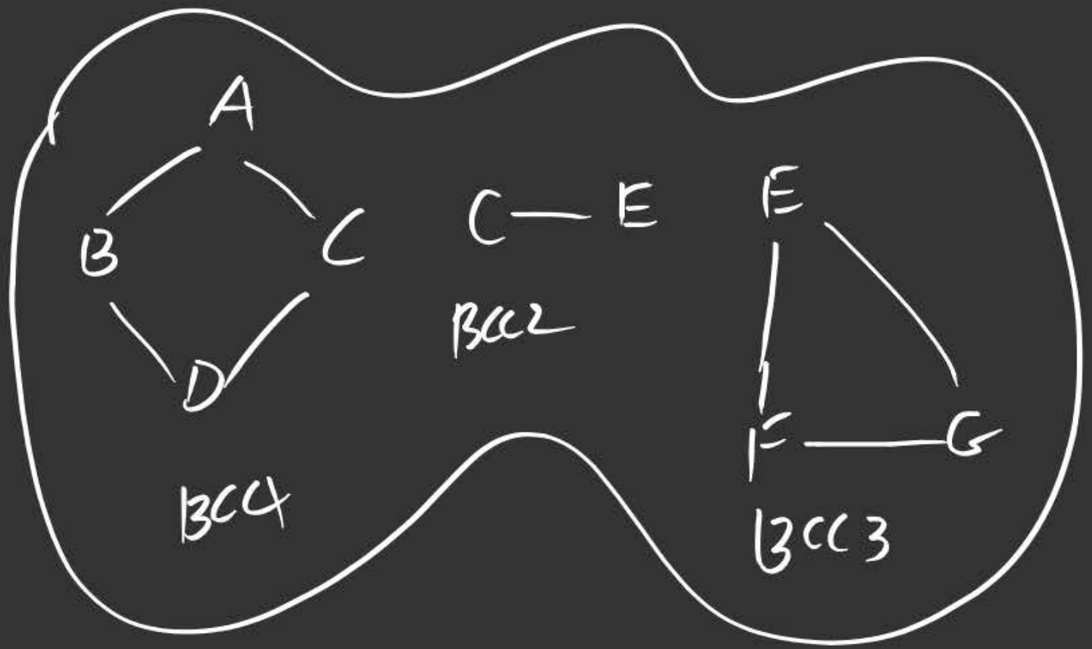
A → APs

B → BCCs

Then $A^B = ?$



BCC



$A = 2$

$B = 3$

$A^B = 2^3 = 8$

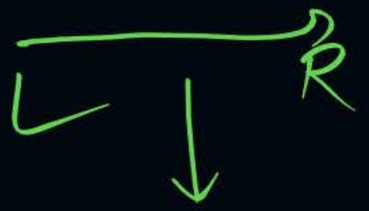
Topic: Miscellaneous

Heaps:

Complete Binary Tree (CBT)

Heaps

1. Max-Heap
2. Min-Heap



1. Max-Heap: (default Heap)

CBT such that value at each node is greater than or equal to all its child.

$\geq$

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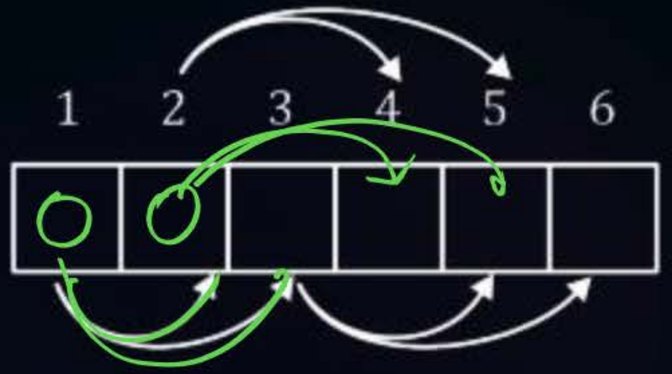
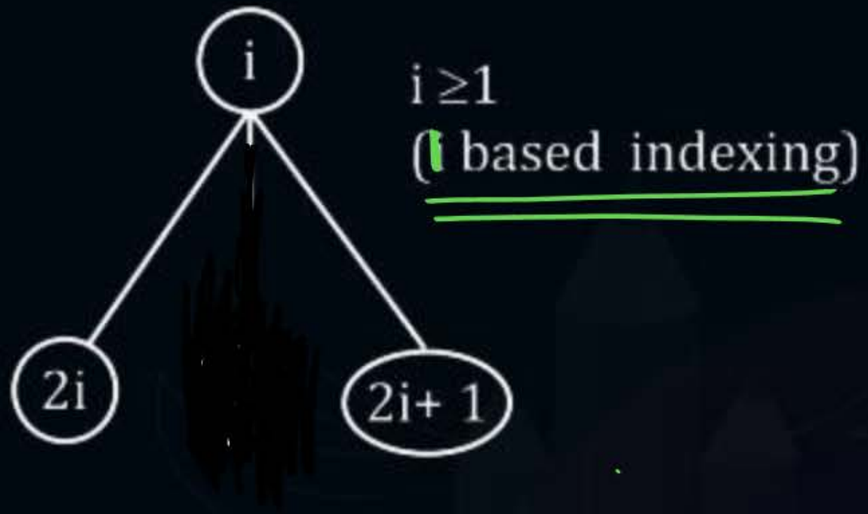
Array reorientation of a CBT:
representation.





i ≥1
(1 based indexing)

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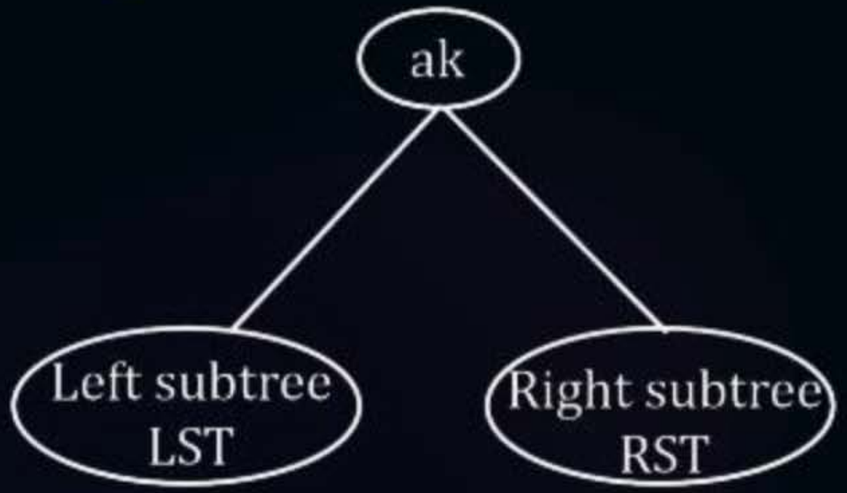
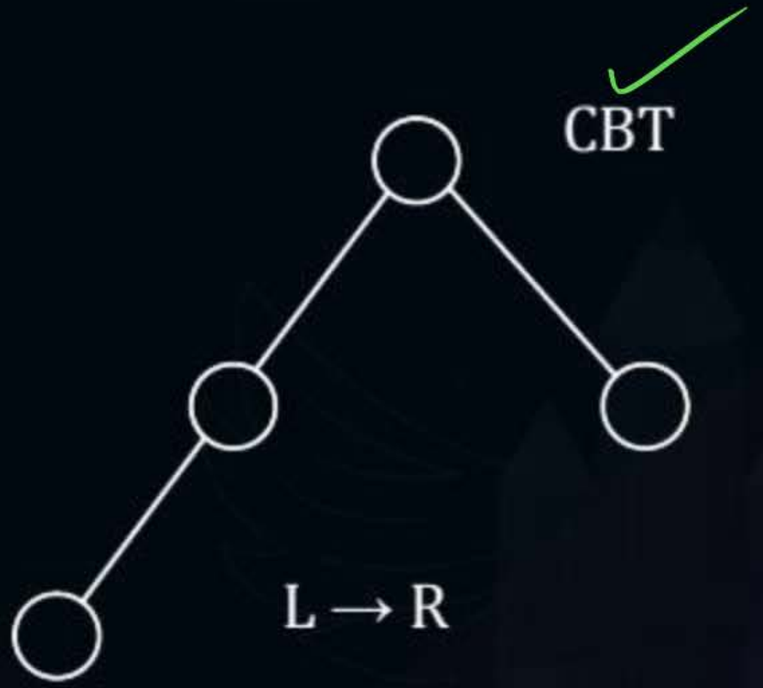
Max Heap



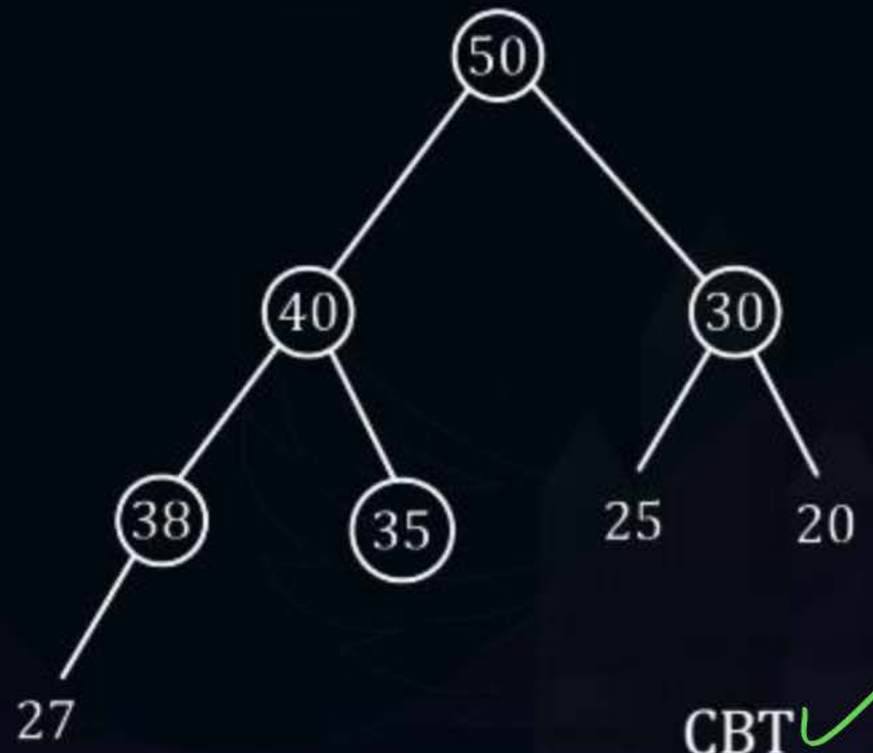
$A_k \geq$ all values in LST & RST



Topic: Miscellaneous

Example:-1

Example:-2

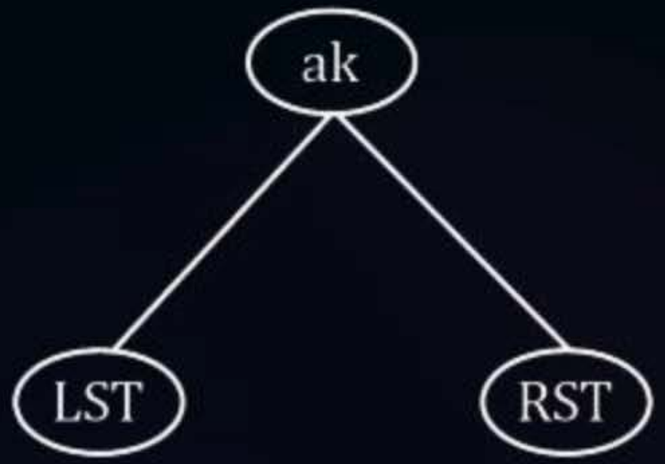


CBT ✓

Max-Heap ✓

Topic: Miscellaneous

Min-Heap



$A_k \leq$ all values in LST & RST

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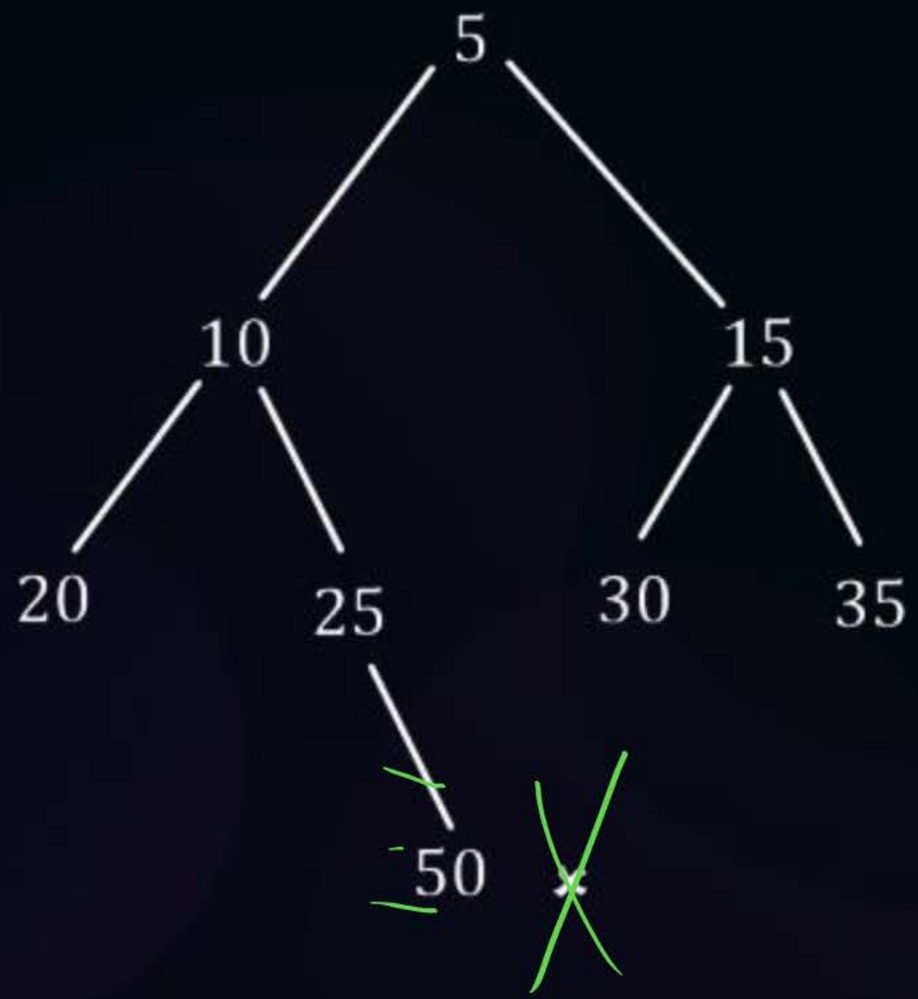
CBT (□)

Example:



L → R

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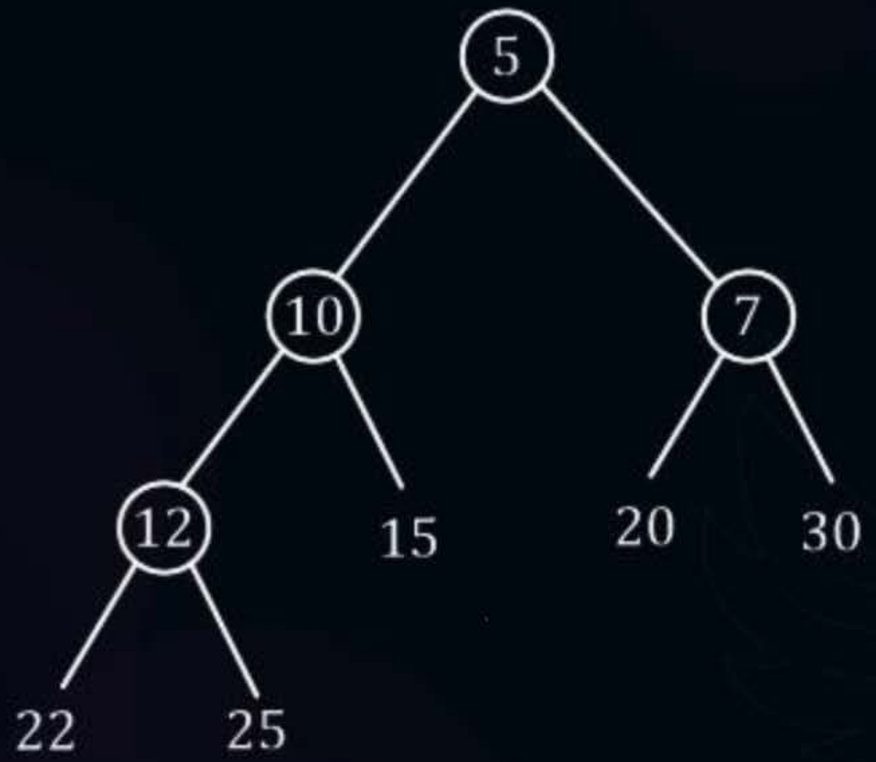
Example:-2



CBT ✓

min Heap ✓

Topic: Miscellaneous

1. Construction of a Heap
   - Insertion method
   - Heapify / Build-Heap method

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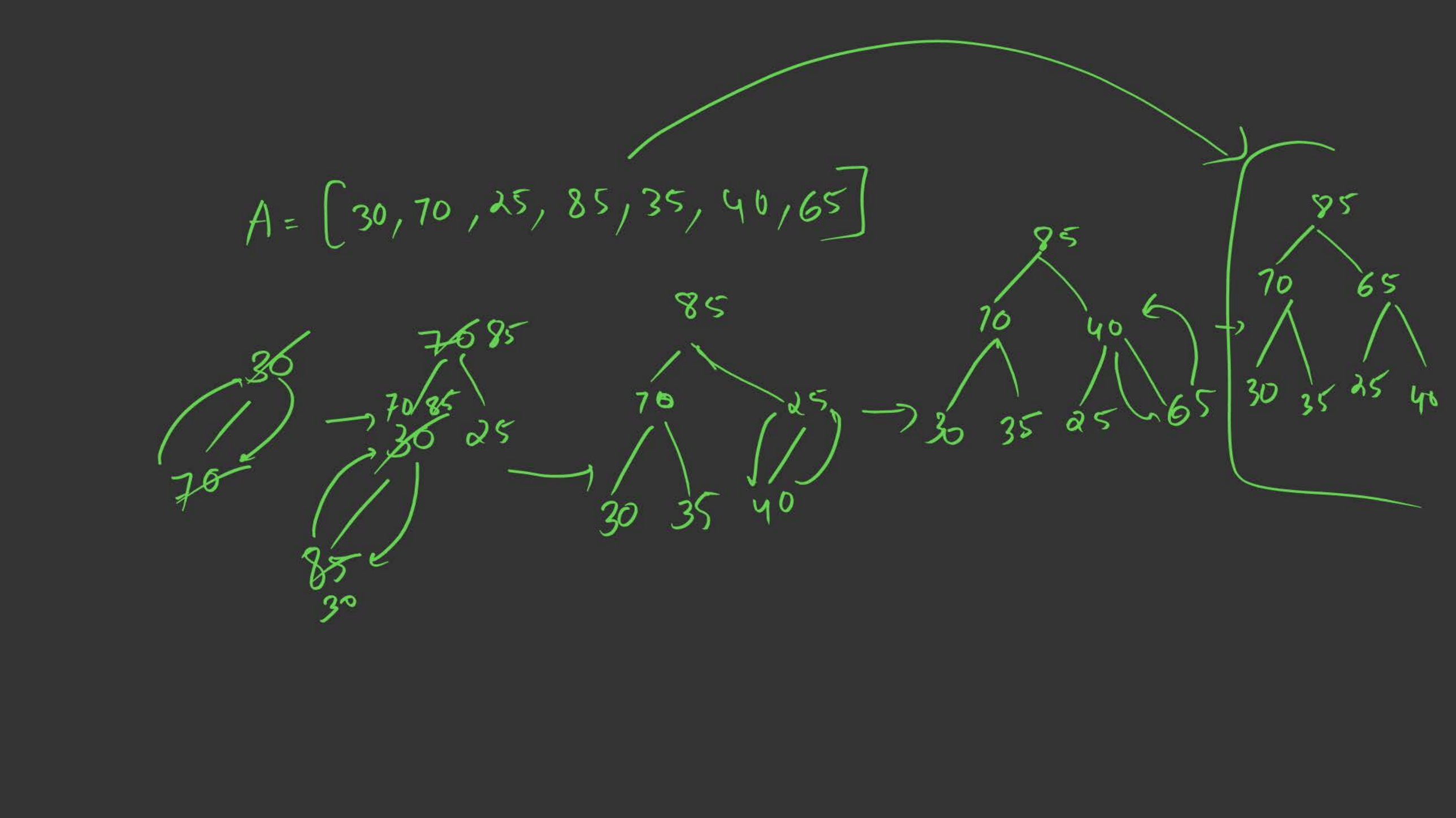
Insertion method: (default: Max-Heap)

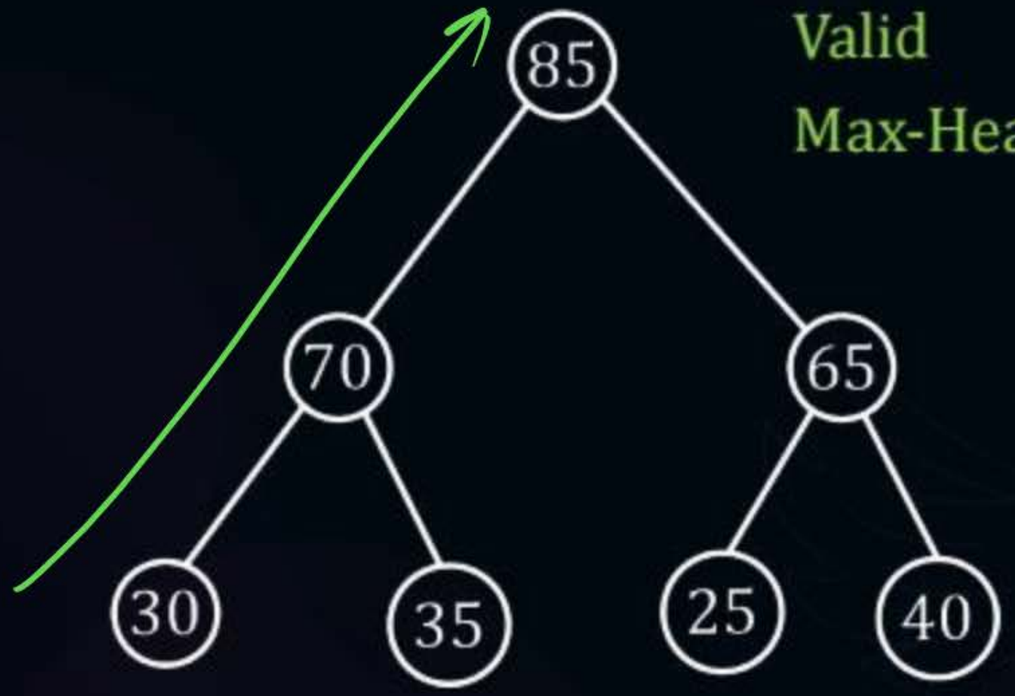
- Start: empty tree
- In CBT format insert one element at a time, always to a valid Heap

Swaps


A = [30, 70, 25, 85, 35, 40, 65]

Topic: Miscellaneous

Final Max-Heap



Valid
Max-Heap

Topic: Miscellaneous

Insert Method:

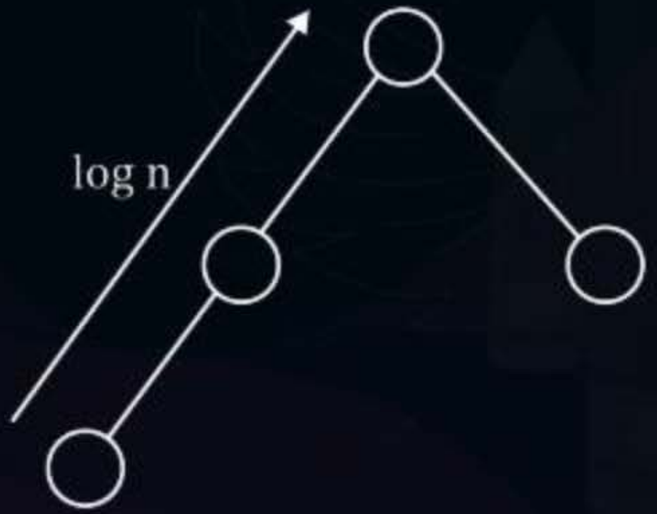
Time Complexity of 1 Insert Operation:

Given a Heap of n elements.

Time Complexity of inserting a new element to it?

O(log n)

Height of CBT of n elements O(log n)



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Time complexity of heap creation using insertion method.

Max-Heap

1. Best case:

   Input array: decreasing order

   every element → complexity : O(1)

   n element → n*1 = Ω(n) comparison

   Best case Ω(n)

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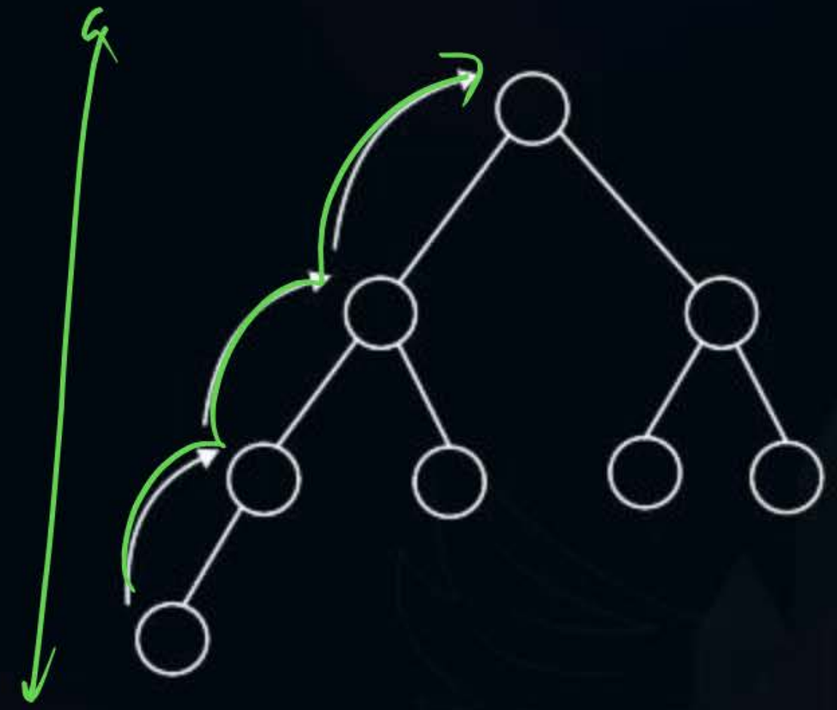
Worst case:

Input: increasing order

every element = O(log n)

for n element = O(n log n)



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Summary:

Heap creation using Insertion method.

$\Omega(n)$

$O(n \log_2 n)$

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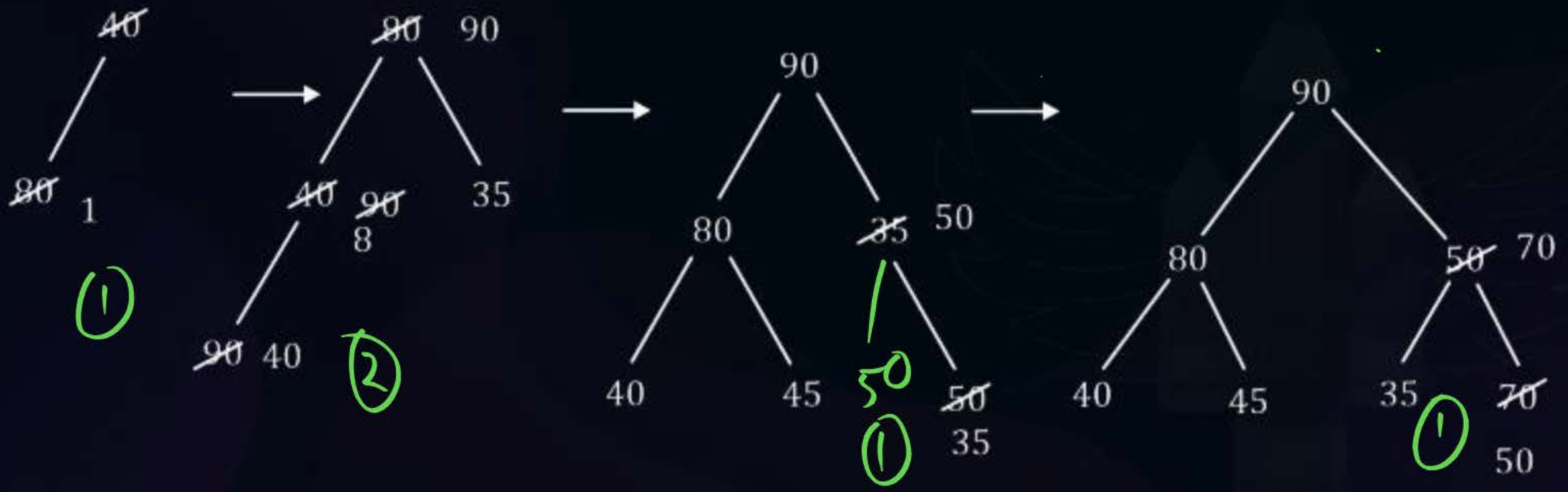
Test:

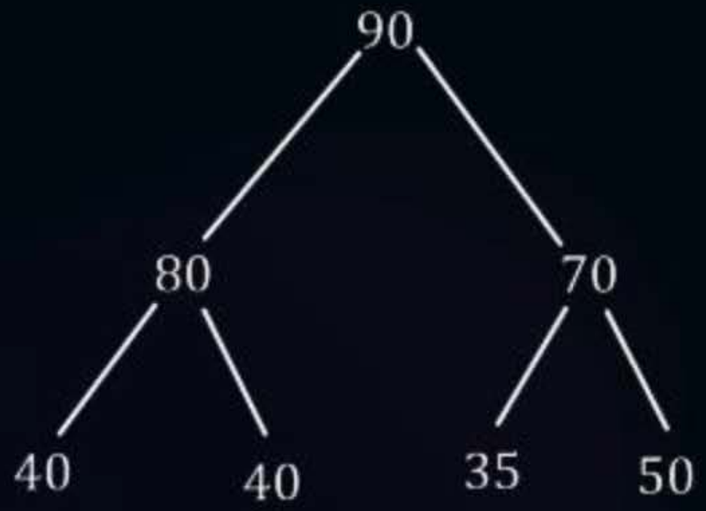
Given A: 40,80,35,90,45,50,70

Create a max-heap using insertion Method. How many swaps are needed?



Topic: Miscellaneous

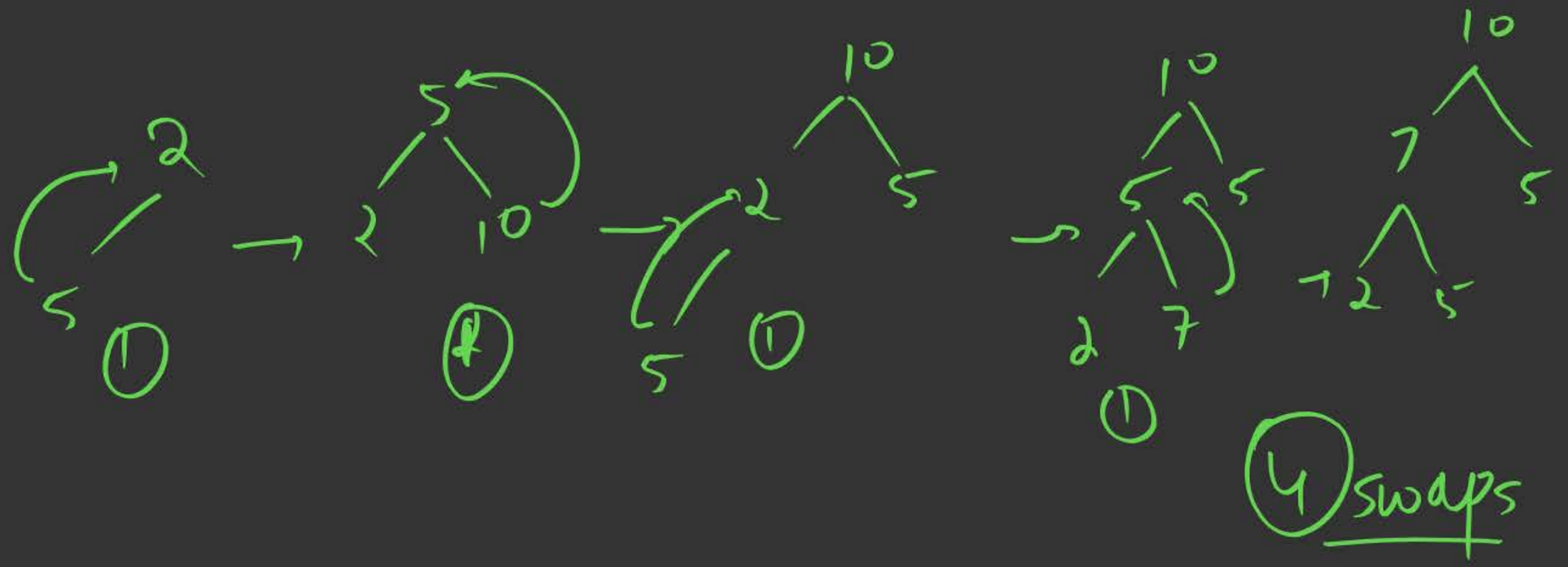
Heap:



Total swap : 1 + 2 + 1 + 1 = 5

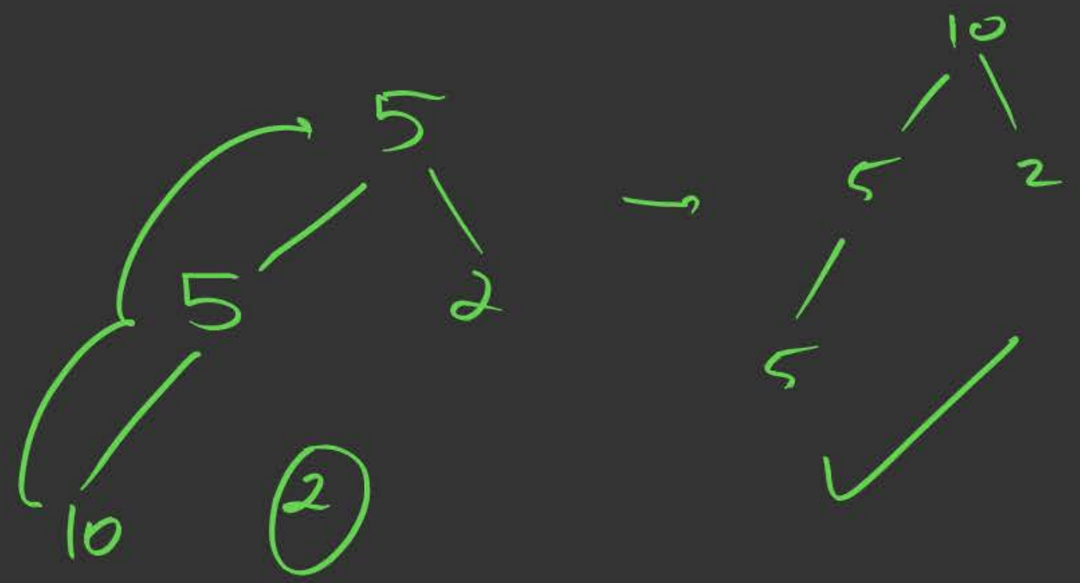
$A = [2, 5, 10, 5, 7]$

max-Heap, swaps = ?



(4) swaps

$A = [5, 5, 2, 10]$



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2. Heap Creation: Heapify / Build-Heap method

Steps:

1. Complete Binary tree already exists of n elements.
2. Make level-by-level adjustments to each node to get to the final Heap.
3. Adjust (Top–Down) a node to move it to its correct position.

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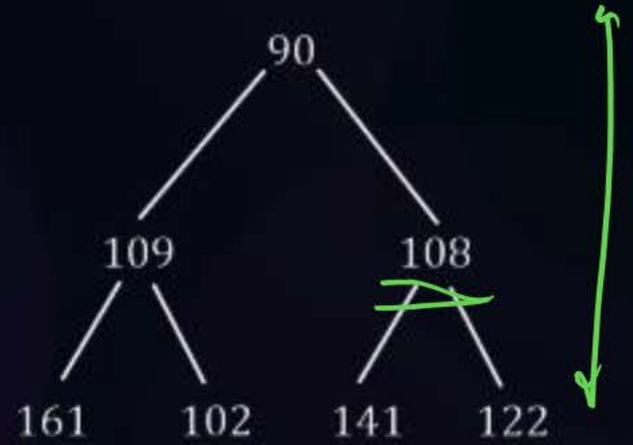
Example:



$\approx \lfloor n/2 \rfloor$ are leaf

Important:

Check for adjustments from non-leaf nodes (2nd last level)

≈ (n/2) nodes at leaf.

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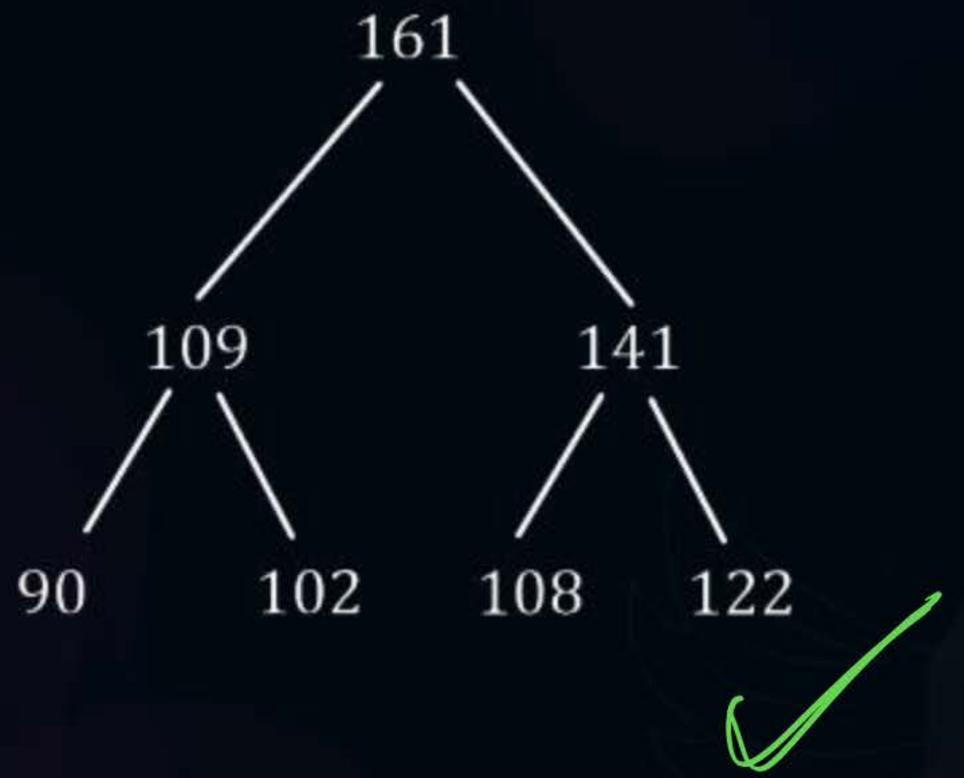
Input:-

Topic: Miscellaneous

~~Final~~

Final Heap →



Max- Heap

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Important:-

For input : A[n]

Build heap/Heapify → TC: O(n) for heap creation.

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Test: A [100, 119, 118, 171, 112, 151, 132]

① insertion

② Heapify ?

[NAT]

#Q. How many swaps for heap creation using:

(a) insertion method? → 4

(b) Heapify method ?

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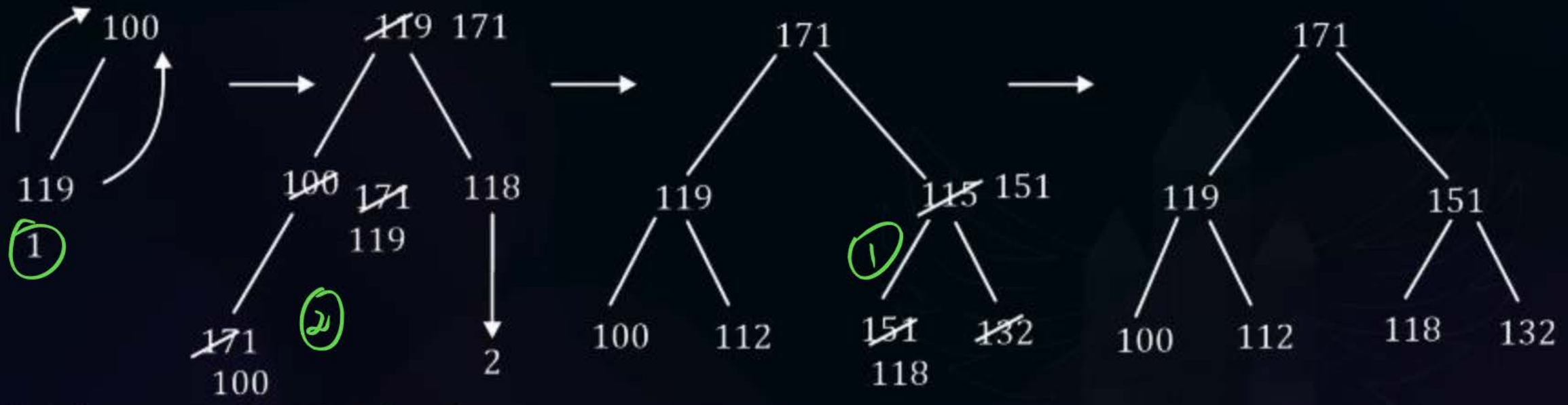
70%

1. Insertion method:

100, 119, 118, 171, 112, 151, 132

max Heap



Total swaps: 1 + 2 + 1 = 4

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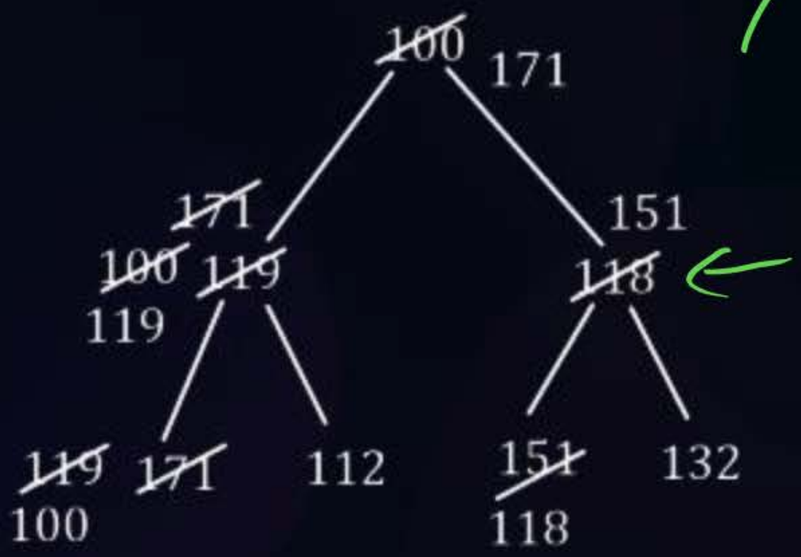
Heapify/ Build –Heap:

100, 119, 118, 171, 112, 151, 132 → CBT



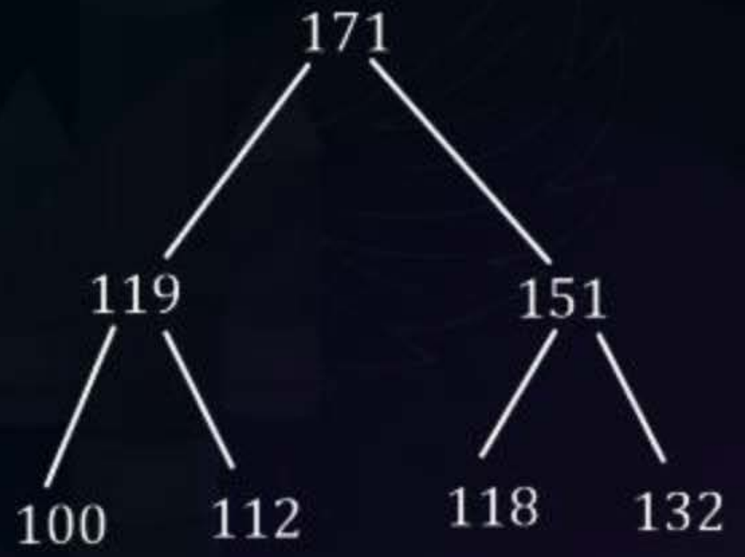
$118 < 151 \rightarrow 1$

$119 < 171 \rightarrow 1$

$108 < 171 \rightarrow 1$

$100 < 119 \rightarrow 1$

4 Swaps



[MSQ]

#Q. Which array representation is a valid binary max-heap?

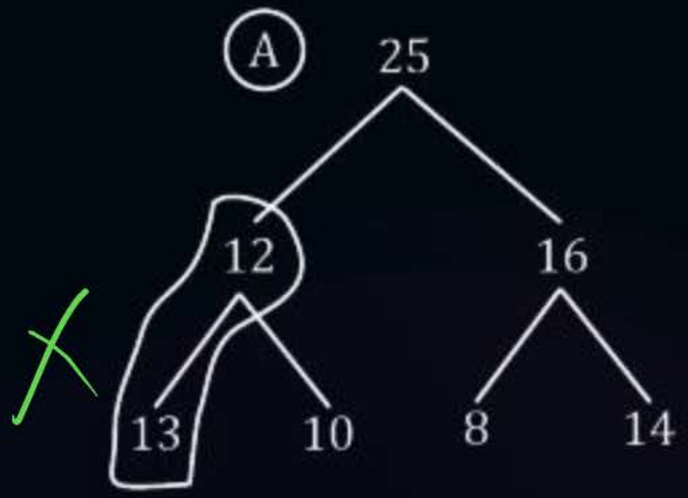
A. 25, 12, 16, 13, 10, 8, 14

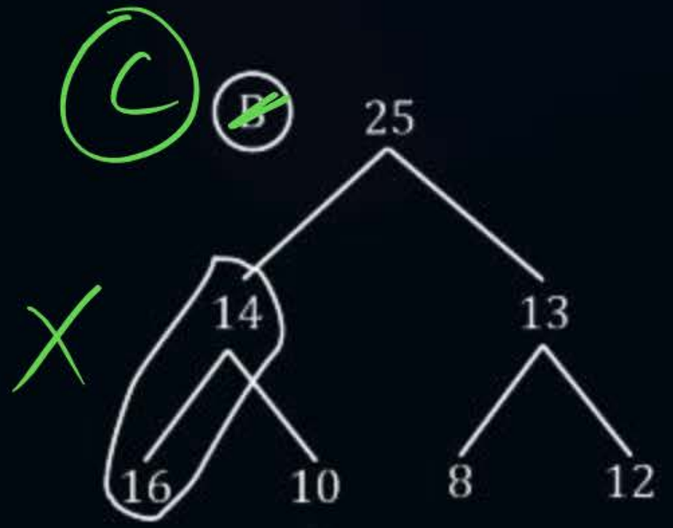
B. 25, 14, 16, 13, 10, 8, 12

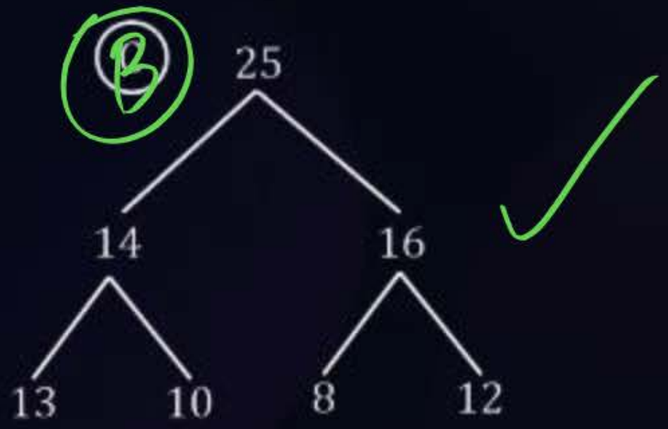
C. 25, 14, 13, 16, 10, 8, 12

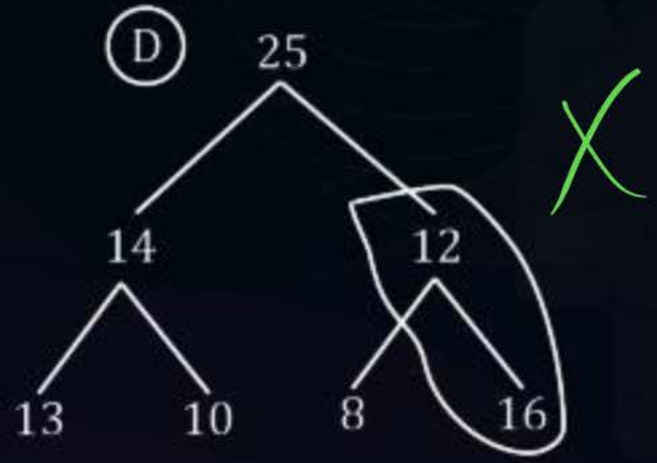
D. 25, 14, 12, 13, 10, 8, 16

Solution


A
25
12
16
13
10
8
14


C
B
25
14
13
16
10
8
12


B
25
14
16
13
10
8
12


D
25
14
12
13
10
8
16

2 mins Summary

Heaps

THANK - YOU