Doubt Clearing Session

Course on C-Programming & Data Structures: GATE - 2024 & 2025

Vishvadeep Gothi • Lesson 58 • Feb 8, 2023

Data Structure
Doubts & Heap PYQs

By: Vishvadeep Gothi

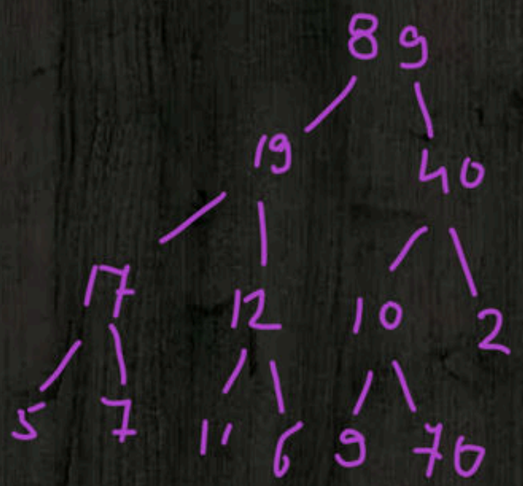
Heap PYQs

Question GATE-1996

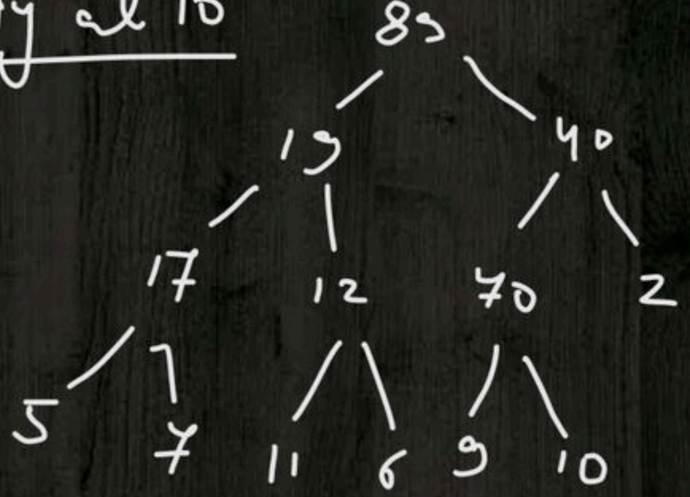
The minimum number of interchanges needed to convert the array into a max-heap is

89, 19, 40, 17, 12, 10, 2, 5, 7, 11, 6, 9, 70

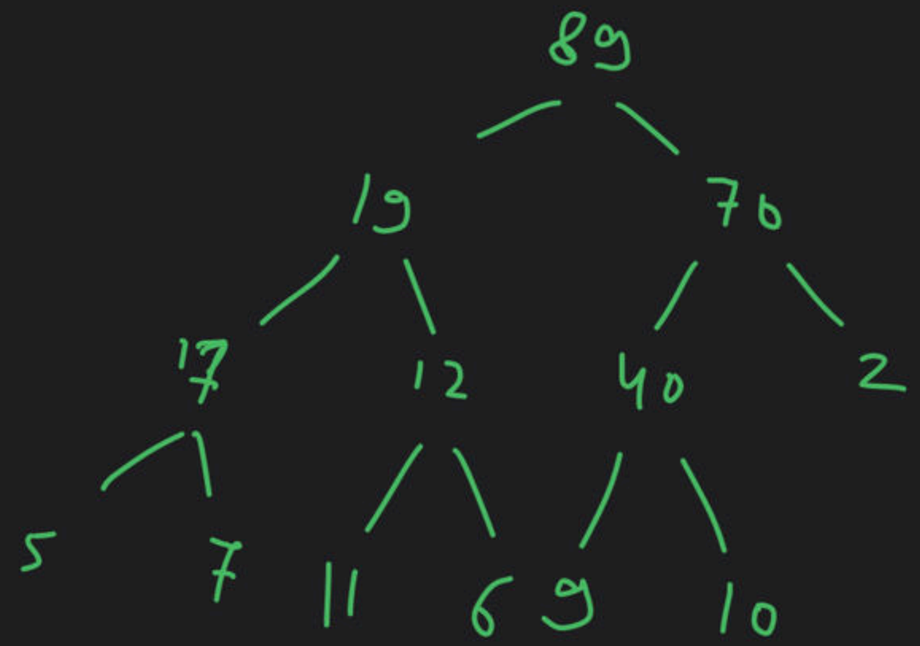
A. 0 B. 1 C. 2 D. 3



heapify at 10

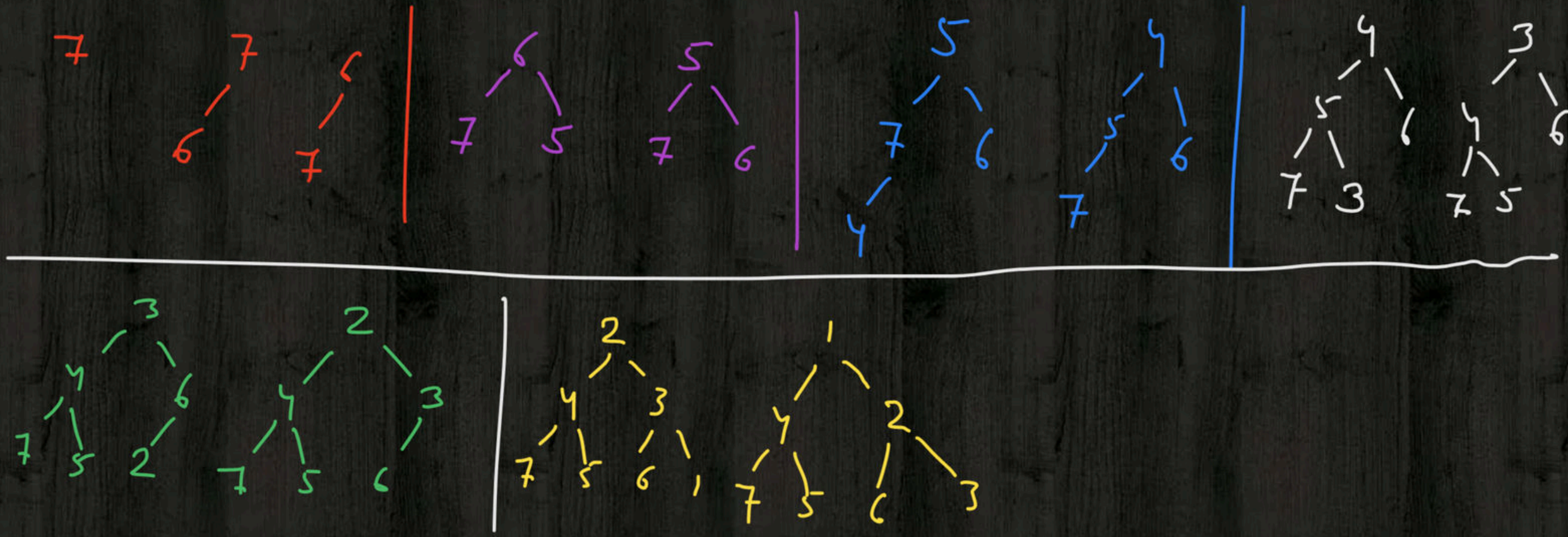


heapify at 40

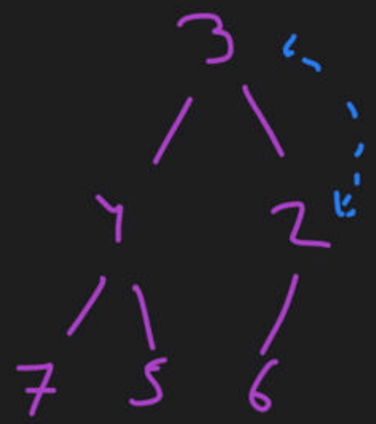

89
19
70
17
12
40
2
5
7
11
6
9
10

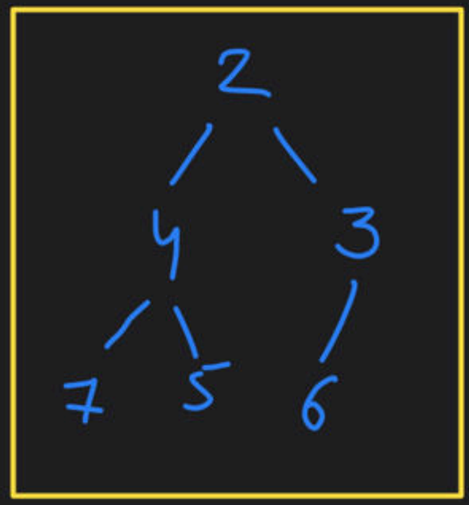
Question GATE-1999

Draw the min-heap that results from insertion of the following elements in order into an initially empty min-heap.
$7, 6, 5, 4, 3, 2, 1$. Show the result after the deletion of the root of this heap.



Delete root:-





Ans.

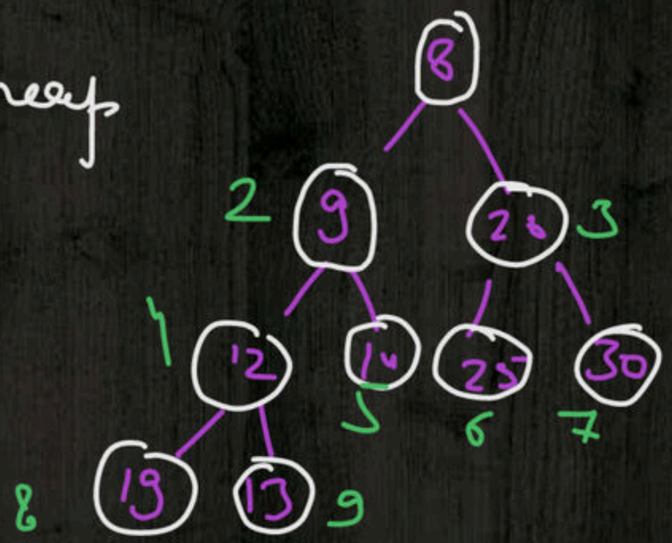
Question GATE-2001

Consider any array representation of an n element binary heap where the elements are stored from index 1 to index n of the array. For the element stored at index i of the array $(i \leq n)$, the index of the parent is

A. $i-1$ B. $\lfloor \frac{i}{2} \rfloor$ C. $\lceil \frac{i}{2} \rceil$ D. $\frac{(i+1)}{2}$

1	2	3	4	5	6	7	8	9	10	...
8	9	20	12	14	25	30	19	13		

ex:- min heap



$$\left\lfloor \frac{i}{2} \right\rfloor$$

Question GATE-2003

In a min-heap with n elements with the smallest element at the root, the 7^{th} smallest element can be found in time

A. $\Theta(n \log n)$
B. $\Theta(n)$
C. $\Theta(\log n)$
D. $\Theta(1)$

2^{nd} smallest ⇒ first 2 levels

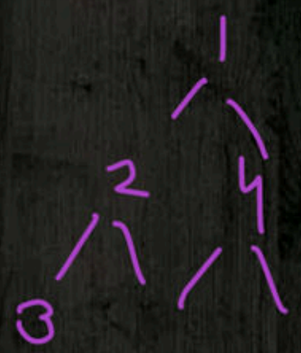
3^{rd} smallest ⇒ first 3 levels

4^{th} — " — ⇒ first 4 levels

:

i^{th} smallest ⇒ first i levels

7^{th} smallest ⇒ first 7 levels ⇒ $2^8 - 1 = 255$

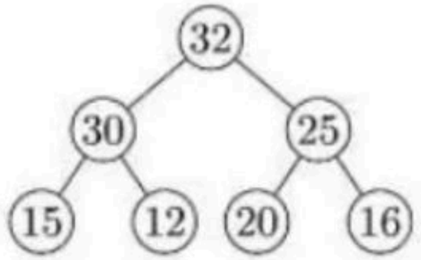


n	T(n)
7	≤ 255
100	≤ 255
1000	≤ 255
50	≤ 255
15	≤ 255

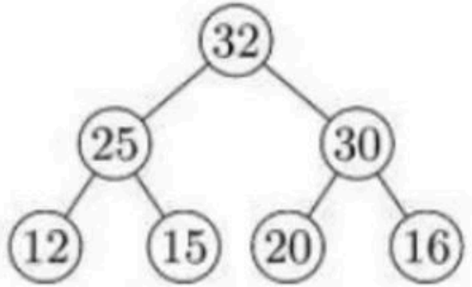
Question GATE-2004

The elements 32, 15, 20, 30, 12, 25, 16, are inserted one by one in the given order into a maxHeap. The resultant maxHeap is

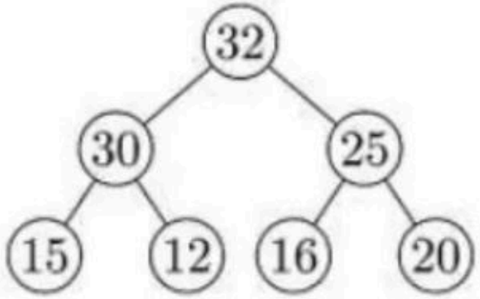
A.



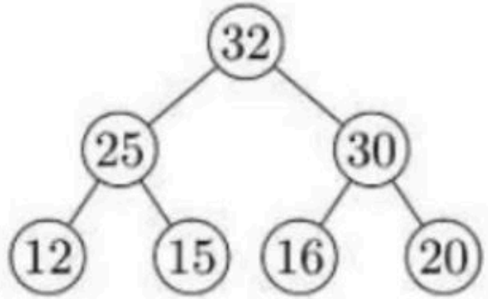
B.

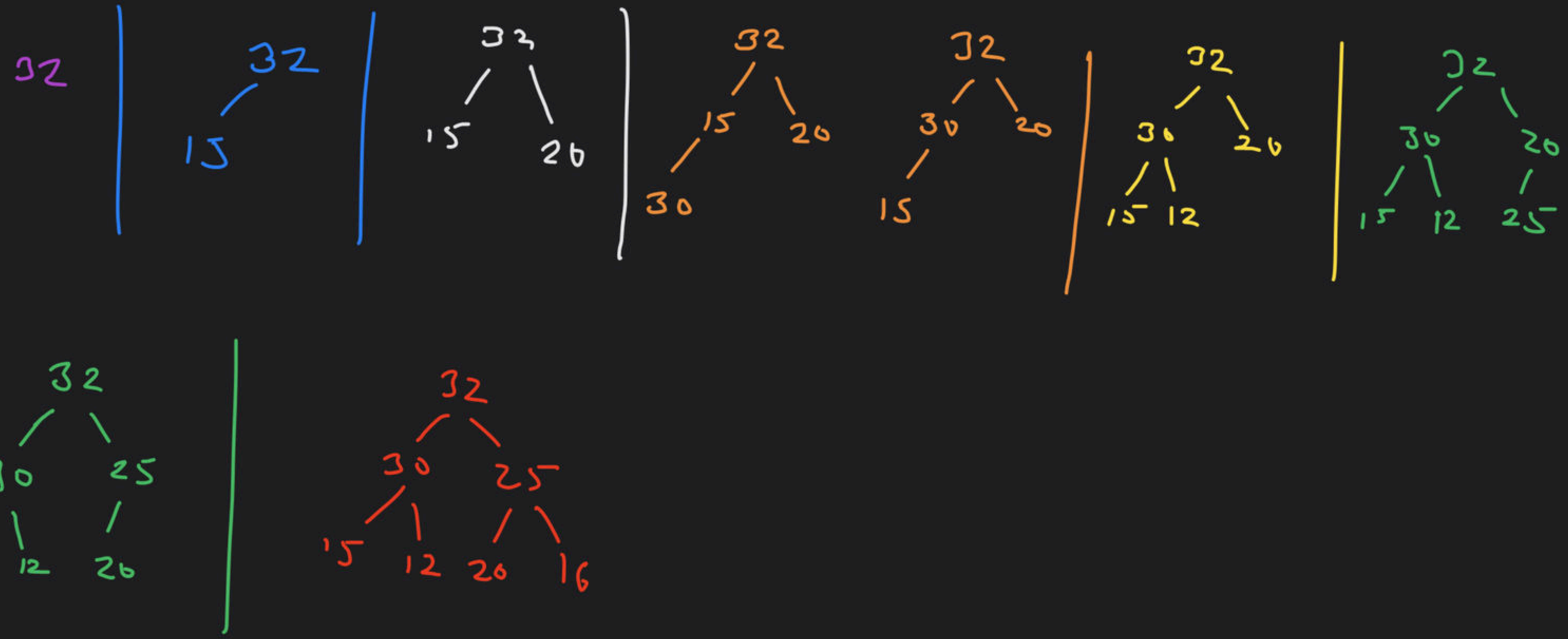


C.



D.




32
32
15
33
15
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32
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20
30
32
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15
12
32
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20
15
12
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32
30
25
15
12
20
32
30
25
15
12
20
16

Question GATE-2004

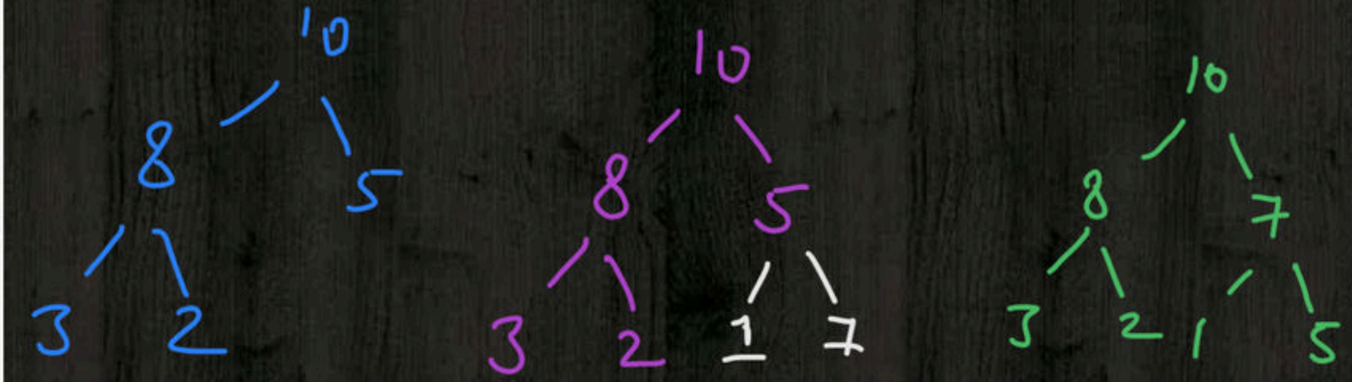
An array of integers of size n can be converted into a heap by adjusting the heaps rooted at each internal node of the complete binary tree starting at the node $\lfloor (n-1)/2 \rfloor$, and doing this adjustment up to the root node (root node is at index 0) in the order $\lfloor (n-1)/2 \rfloor$, $\lfloor (n-3)/2 \rfloor$, ..., 0. The time required to construct a heap in this manner is

A. $O(\log n)$ B. $O(n)$ C. $O(n \log \log n)$ D. $O(n \log n)$

Question GATE-2005

A priority queue is implemented as a Max-Heap. Initially, it has 5 elements. The level-order traversal of the heap is: $10,8,5,3,2$. Two new elements 1 and 7 are inserted into the heap in that order. The level-order traversal of the heap after the insertion of the elements is:

A. $10,8,7,5,3,2,1$
B. $10,8,7,2,3,1,5$
C. $10,8,7,1,2,3,5$
D. $10,8,7,3,2,1,5$



Question GATE-2006

In a binary max heap containing n numbers, the smallest element can be found in time

A. $O(n)$
B. $O(\log n)$
C. $O(\log \log n)$
D. $O(1)$

Question GATE-2006

A 3-ary max heap is like a binary max heap, but instead of 2 children, nodes have 3 children. A 3-ary heap can be represented by an array as follows: The root is stored in the first location, $a[0]$, nodes in the next level, from left to right, is stored from $a[1]$ to $a[3]$. The nodes from the second level of the tree from left to right are stored from $a[4]$ location onward. An item x can be inserted into a 3-ary heap containing n items by placing x in the location $a[n]$ and pushing it up the tree to satisfy the heap property.

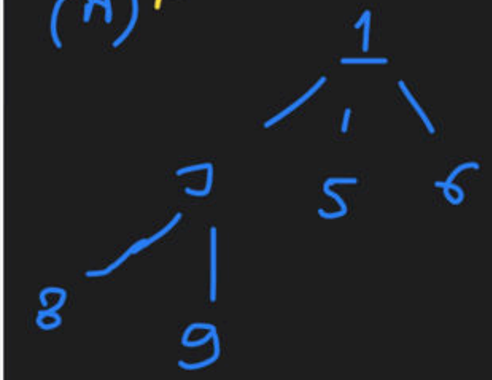
Which one of the following is a valid sequence of elements in an array representing 3-ary max heap?

A. $1,3,5,6,8,9$
B. $9,6,3,1,8,5$
C. $9,3,6,8,5,1$
D. $9,5,6,8,3,1$

Suppose the elements $7,2,10$ and 4 are inserted, in that order, into the valid 3-ary max heap found in the previous question, [illegible]. Which one of the following is the sequence of items in the array representing the resultant heap?

A. $10,7,9,8,3,1,5,2,6,4$
B. $10,9,8,7,6,5,4,3,2,1$
C. $10,9,4,5,7,6,8,2,1,3$
D. $10,8,6,9,7,2,3,4,1,5$

(A)


1
3
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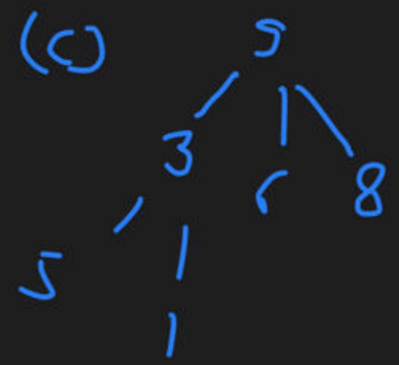
9

(B)


9
6
3
1
8
5

(C)


9
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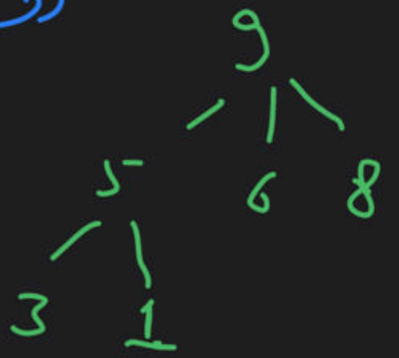
8
5
1

(D)


9
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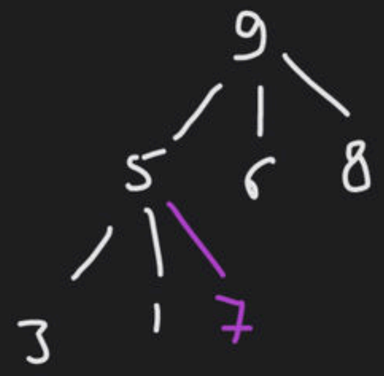
1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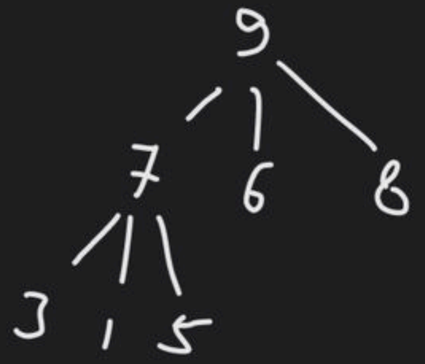
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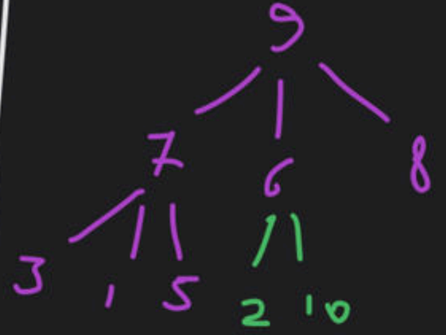
5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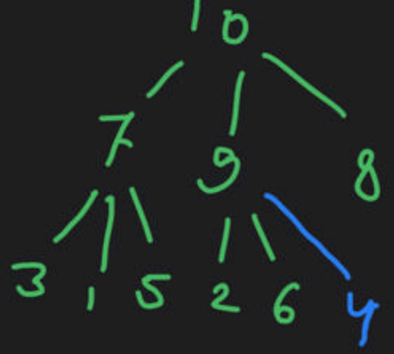
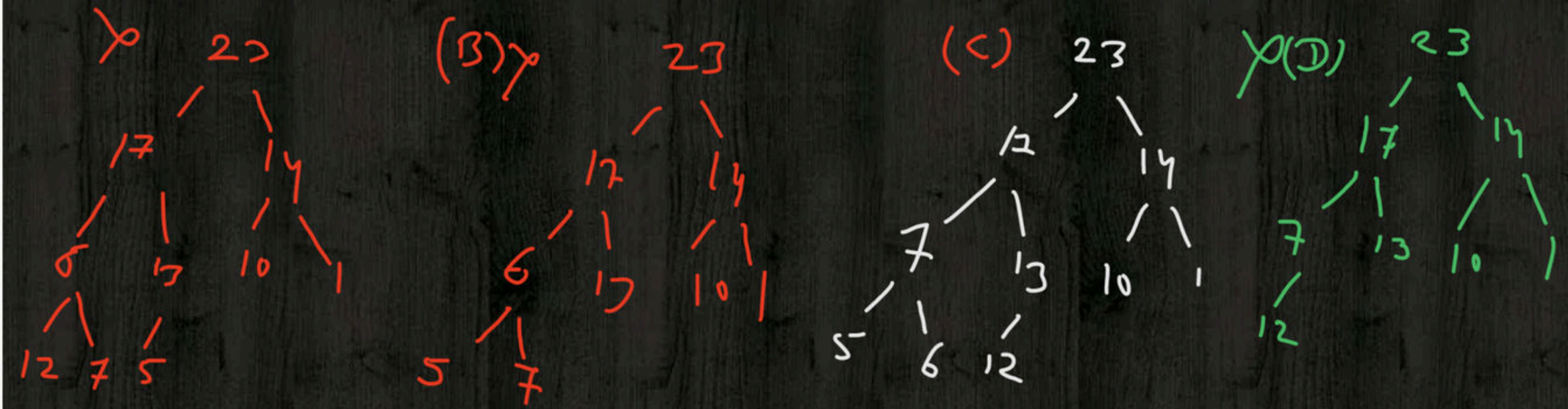

10
7
9
8
3
1
5
2
6
4

Question GATE-2006

Which of the following sequences of array elements forms a heap?

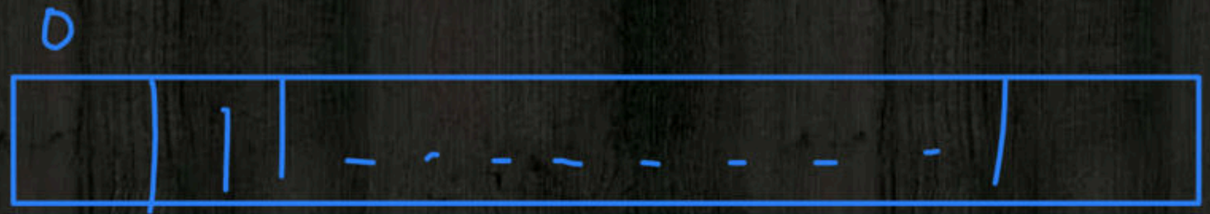
A. {23, 17, 14, 6, 13, 10, 1, 12, 7, 5}
B. {23, 17, 14, 6, 13, 10, 1, 5, 7, 12}
C. {23, 17, 14, 7, 13, 10, 1, 5, 6, 12}
D. {23, 17, 14, 7, 13, 10, 1, 12, 5, 7}

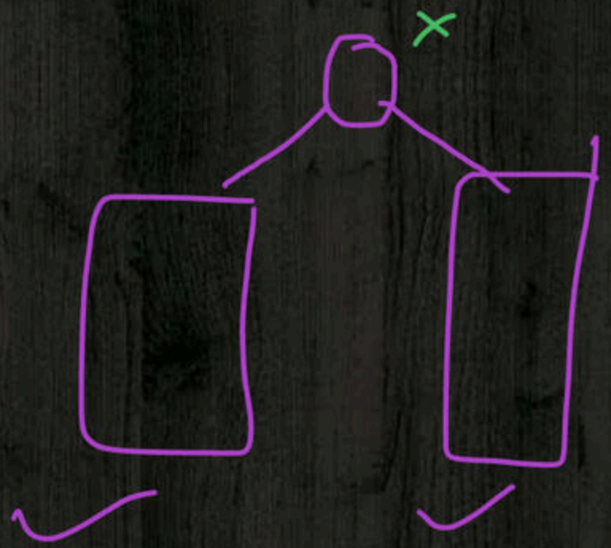


Question GATE-2006

An array X of n distinct integers is interpreted as a complete binary tree. The index of the first element of the array is 0. If only the root node does not satisfy the heap property, the algorithm to convert the complete binary tree into a heap has the best asymptotic time complexity of

A. $O(n)$ B. $O(\log n)$ C. $O(n \log n)$ D. $O(n \log \log n)$





Question GATE-2007

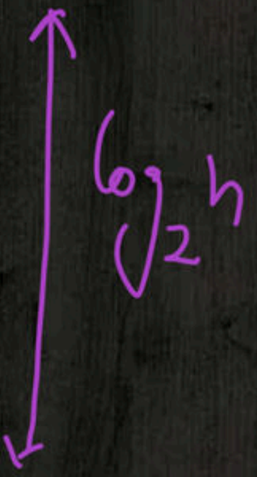
Consider the process of inserting an element into a *Max Heap*, where the *Max Heap* is represented by an *array*. Suppose we perform a binary search on the path from the new leaf to the root to find the position for the newly inserted element, the number of *comparisons* performed is:

A. $\Theta(\log_2 n)$

B. $\Theta(\log_2 \log_2 n)$

C. $\Theta(n)$

D. $\Theta(n \log_2 n)$

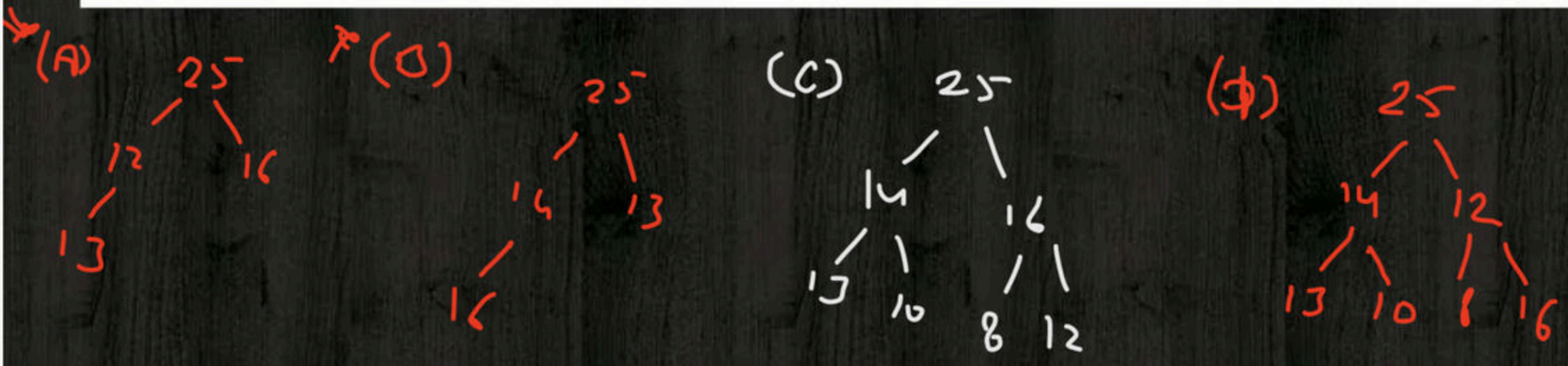


$\log_2 \log_2 n$

Question GATE-2009

Consider a binary max-heap implemented using an array.
Which one of the following array represents a binary max-heap?

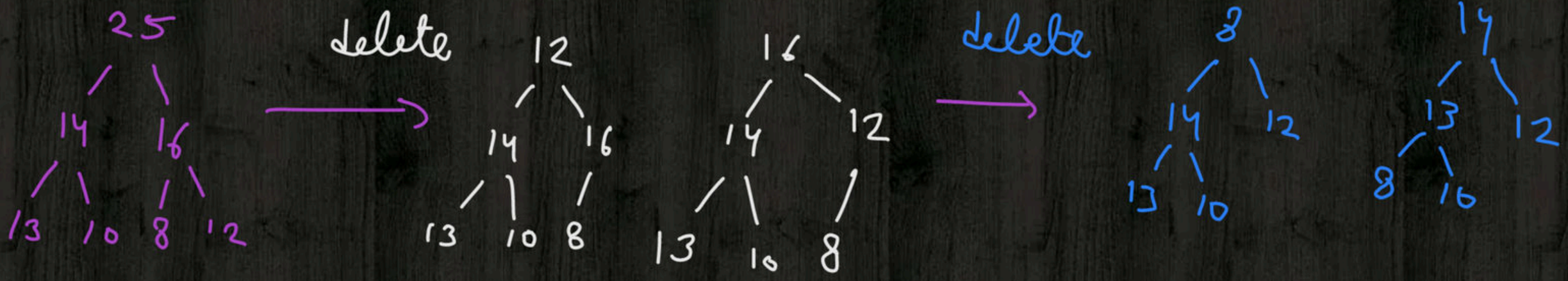
A. {25, 12, 16, 13, 10, 8, 14}
B. {25, 14, 13, 16, 10, 8, 12}
C. {25, 14, 16, 13, 10, 8, 12}
D. {25, 14, 12, 13, 10, 8, 16}



Question GATE-2009

Consider a binary max-heap implemented using an array.
What is the content of the array after two delete operations on $\{25, 14, 16, 13, 10, 8, 12\}$

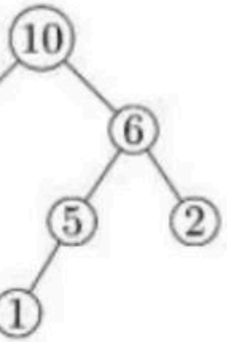
A. $\{14, 13, 12, 10, 8\}$
B. $\{14, 12, 13, 8, 10\}$
C. $\{14, 13, 8, 12, 10\}$
D. $\{14, 13, 12, 8, 10\}$



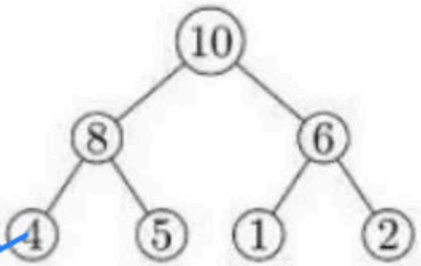
Question GATE-2011

A max-heap is a heap where the value of each parent is greater than or equal to the value of its children. Which of the following is a max-heap?

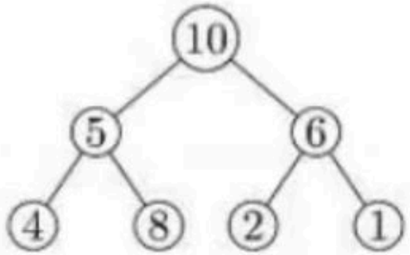
A.



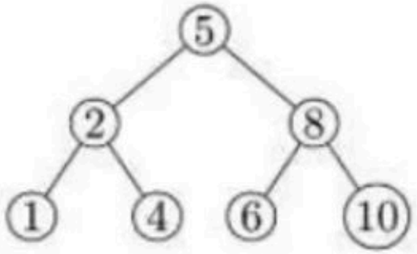
B.



C.



D.



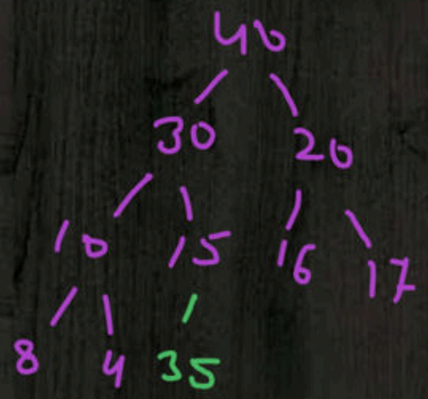
Question GATE-2015

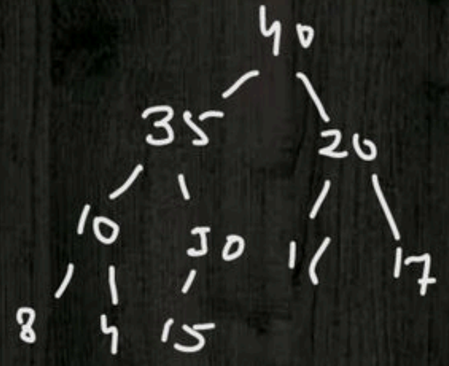
Consider a max heap, represented by the array: $40, 30, 20, 10, 15, 16, 17, 8, 4$.

Array index	1	2	3	4	5	6	7	8	9
Value	40	30	20	10	15	16	17	8	4

Now consider that a value 35 is inserted into this heap. After insertion, the new heap is

A. $40, 30, 20, 10, 15, 16, 17, 8, 4, 35$
B. $40, 35, 20, 10, 30, 16, 17, 8, 4, 15$
C. $40, 30, 20, 10, 35, 16, 17, 8, 4, 15$
D. $40, 35, 20, 10, 15, 16, 17, 8, 4, 30$

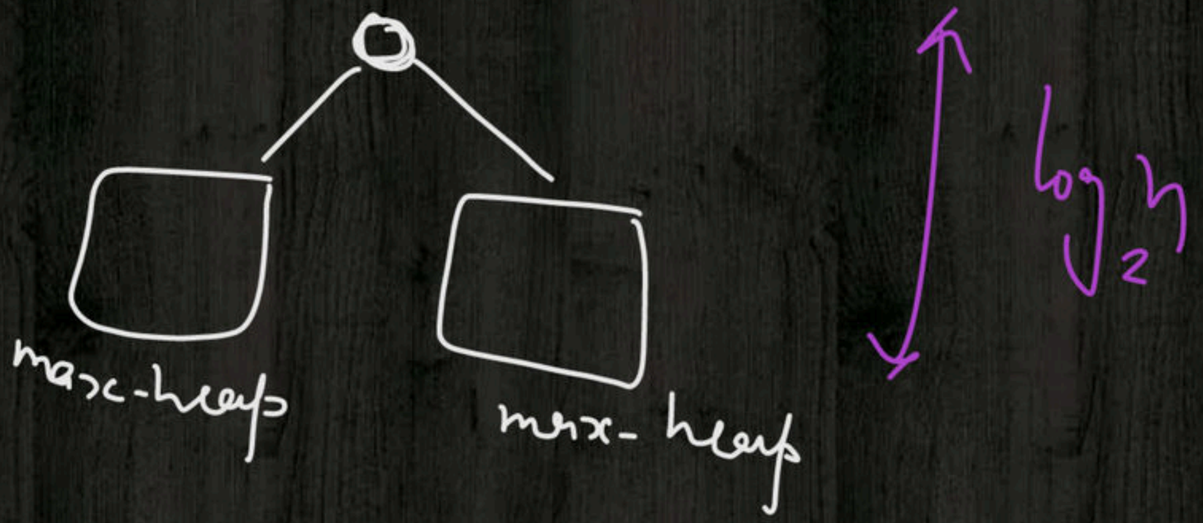




Question GATE-2015

Consider a complete binary tree where the left and right subtrees of the root are max-heaps. The lower bound for the number of operations to convert the tree to a heap is

A. $\Omega(\log n)$
B. $\Omega(n)$
C. $\Omega(n \log n)$
D. $\Omega(n^2)$



Question GATE-2015

Consider the following array of elements.

$\langle 89, 19, 50, 17, 12, 15, 2, 5, 7, 11, 6, 9, 100 \rangle$

The minimum number of interchanges needed to convert it into a max-heap is

A. 4 B. 5 C. 2 D. 3

Question GATE-2016

An operator $delete(i)$ for a binary heap data structure is to be designed to delete the item in the i-th node. Assume that the heap is implemented in an array and i refers to the i-th index of the array. If the heap tree has depth d (number of edges on the path from the root to the farthest leaf), then what is the time complexity to re-fix the heap efficiently after the removal of the element?

A. $O(1)$
B. $O(d)$ but not $O(1)$
C. $O(2^d)$ but not $O(d)$
D. $O(d\,2^d)$ but not $O(2^d)$

Question GATE-2016

A complete binary min-heap is made by including each integer in $[1, 1023]$ exactly once. The depth of a node in the heap is the length of the path from the root of the heap to that node. Thus, the root is at depth 0. The maximum depth at which integer 9 can appear is _____.

Question GATE-2018

The number of possible min-heaps containing each value from $\{1, 2, 3, 4, 5, 6, 7\}$ exactly once is _____

Question GATE-2019

Consider the following statements:

I. The smallest element in a max-heap is always at a leaf node
II. The second largest element in a max-heap is always a child of a root node
III. A max-heap can be constructed from a binary search tree in $\theta(n)$ time
IV. A binary search tree can be constructed from a max-heap in $\theta(n)$ time

Which of te above statements are TRUE?

A. I, II and III
B. I, II and IV
C. I, III and IV
D. II, III and IV

Question GATE-2020

Consider the array representation of a binary min-heap containing 1023 elements. The minimum number of comparisons required to find the maximum in the heap is _____ .

Happy Learning

VD's spartans

@vdeep10