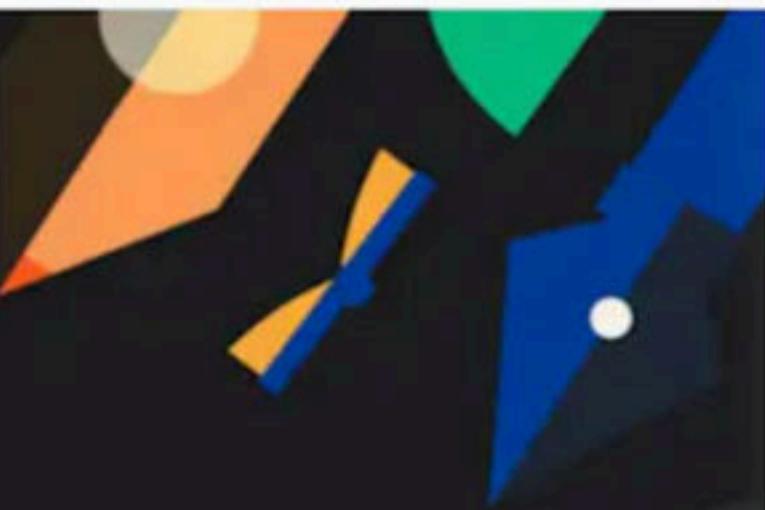




Doubt Class With Lakshay Bhaiya

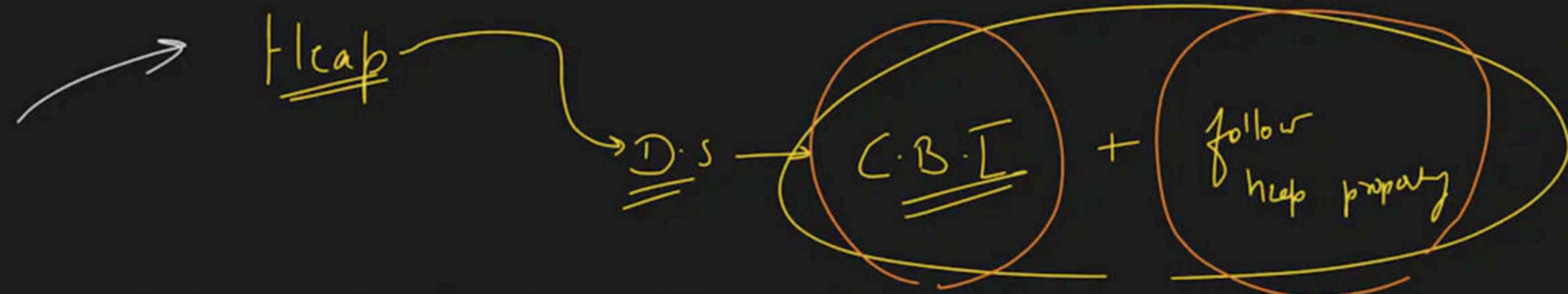
Special class



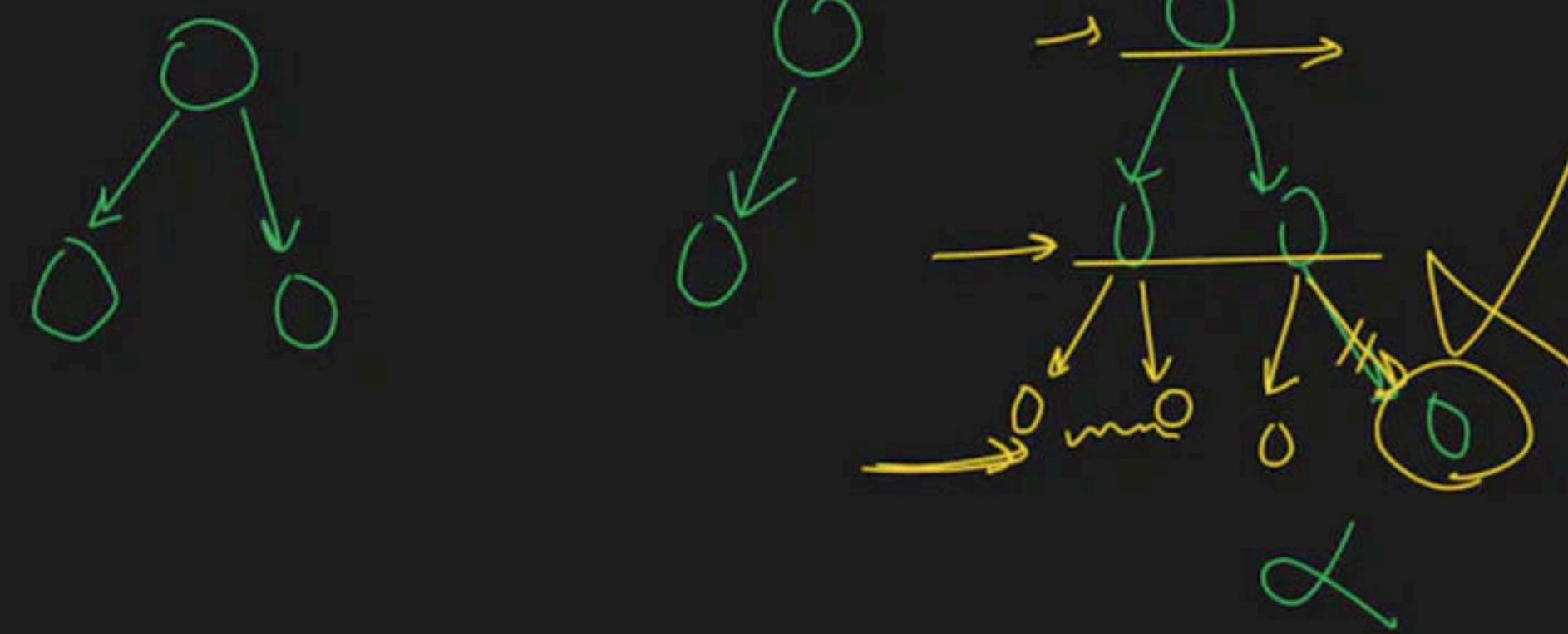
Heaps Class-1

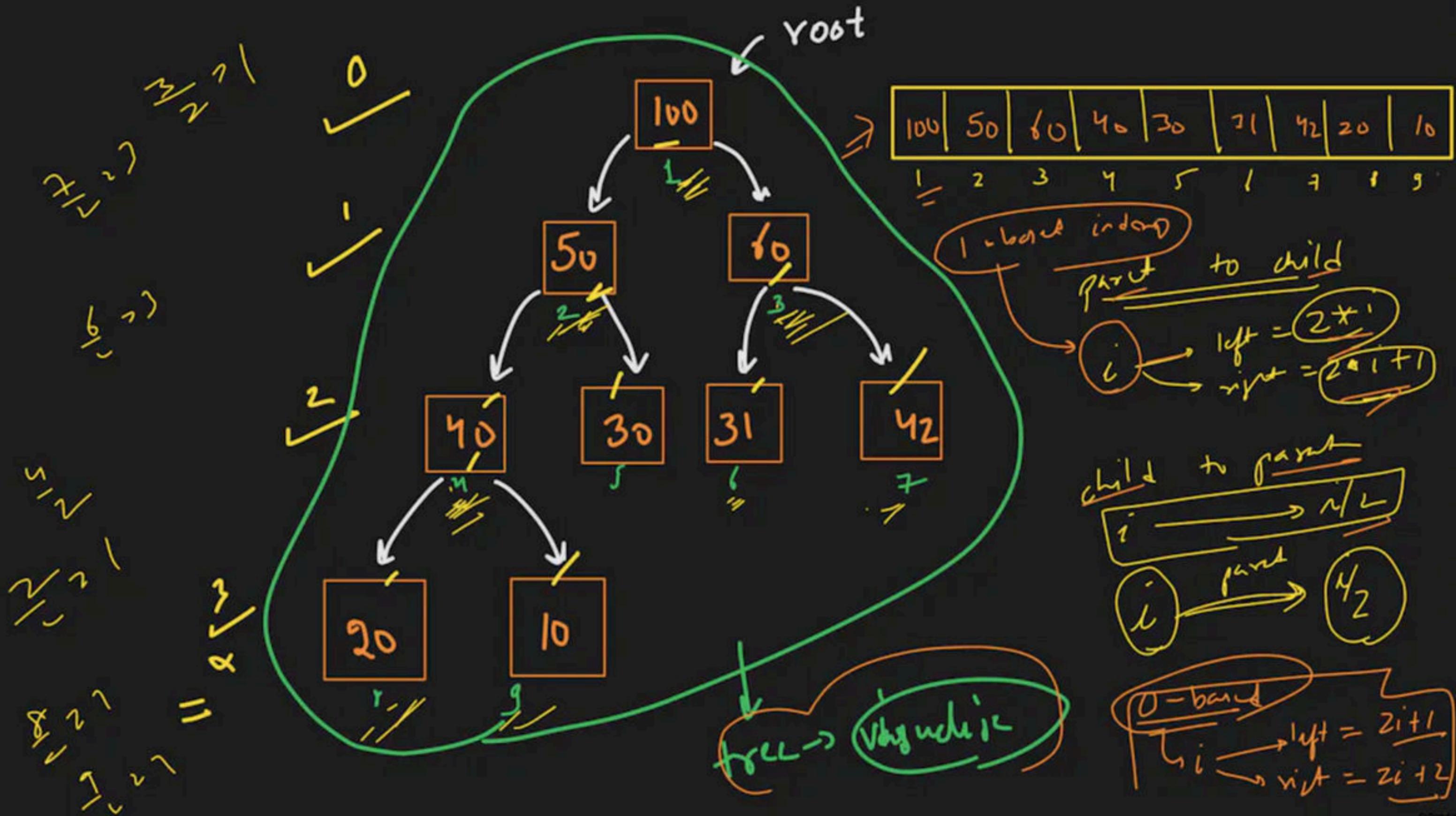
Special class

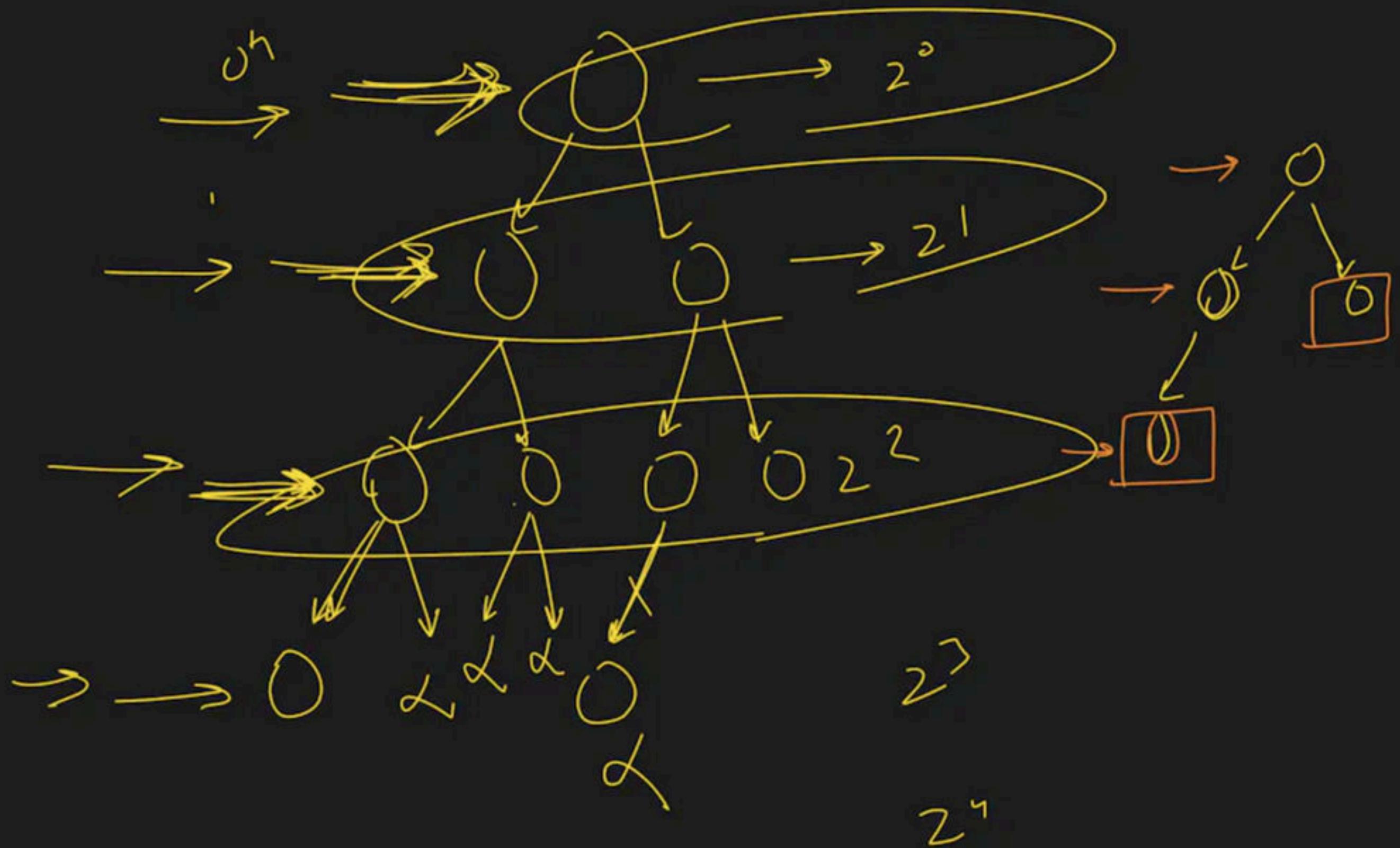
Love Babbar • Dec 15, 2023

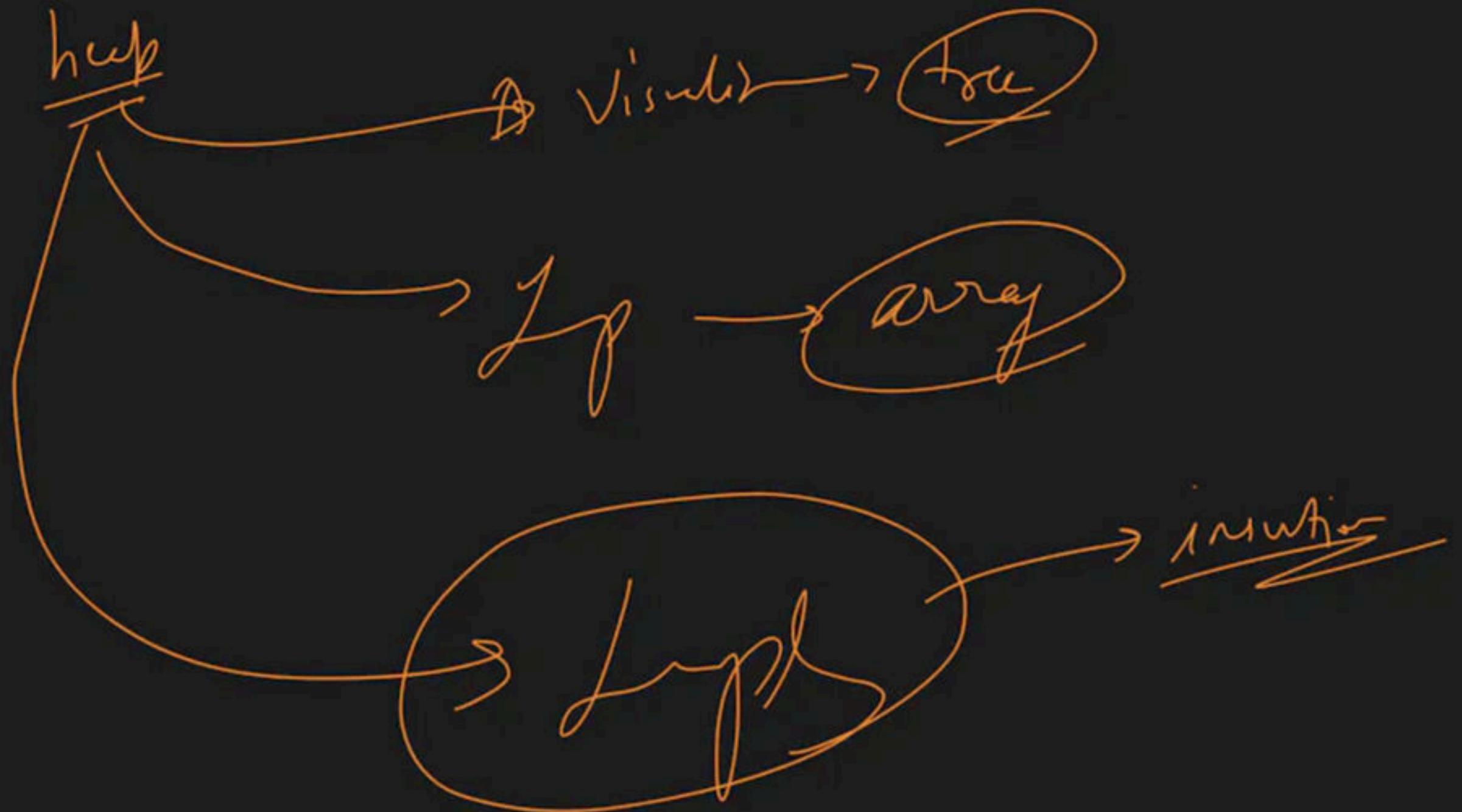


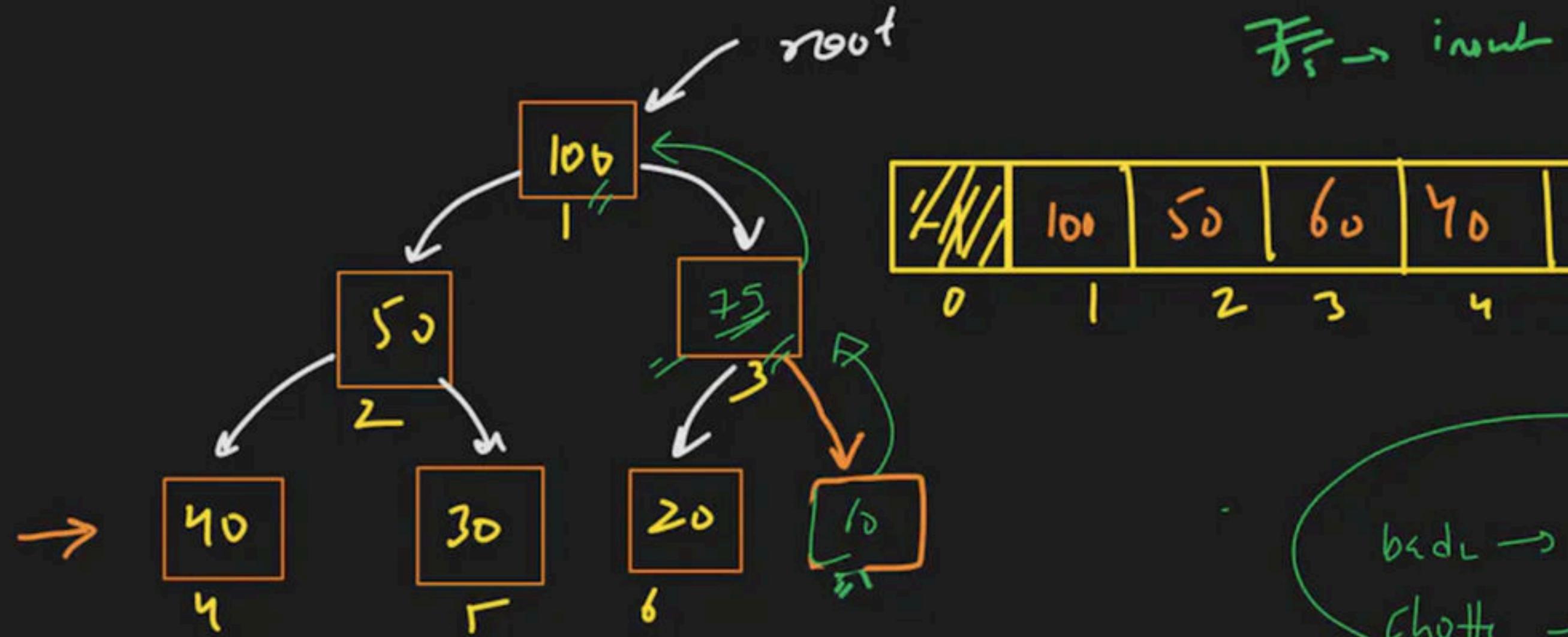
$C.B.T \rightarrow$ Complete Binary Tree









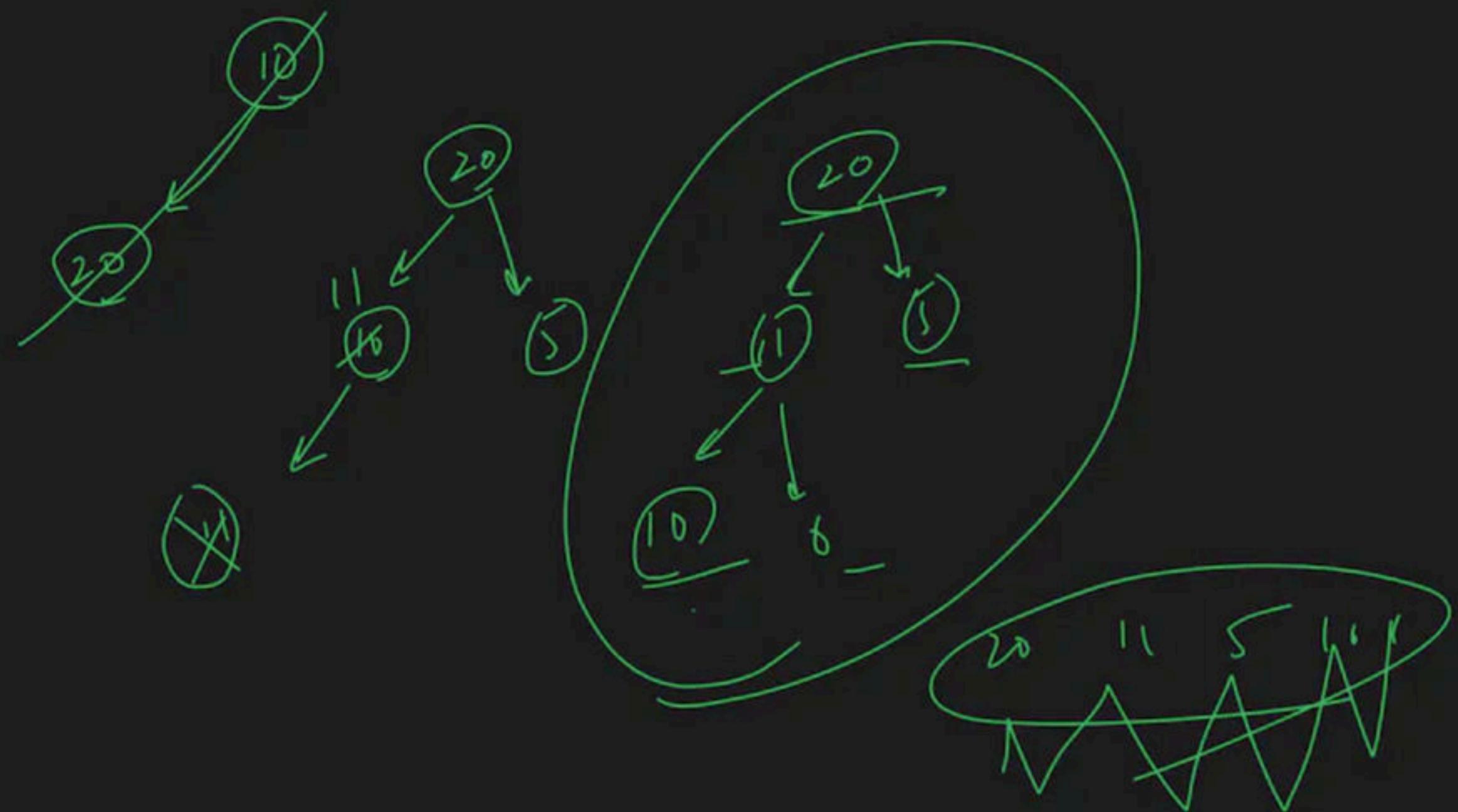


insulation

① **input** **fis** → the vacant/available position
 ② **correction pointer**

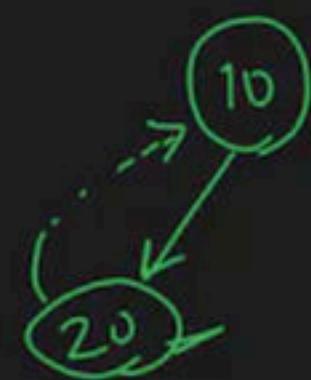
badl → swap
 chott → ignore / stop

10 20 5 11 6

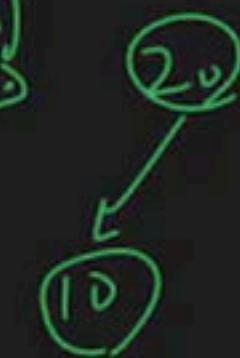
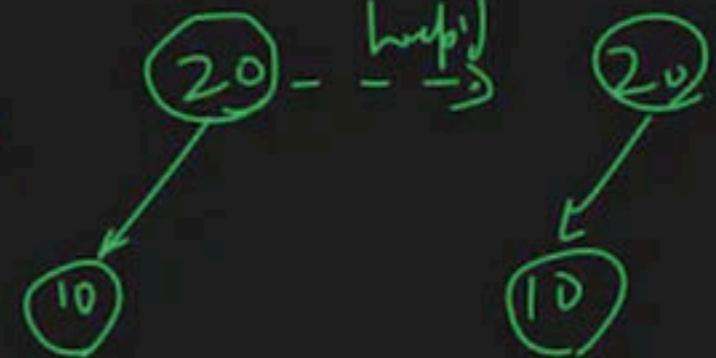


10 $\xrightarrow{\text{20}}$ $\xleftarrow{\text{5}}$ $\xrightleftharpoons{\text{10}}$ $\xleftarrow{\text{2}}$

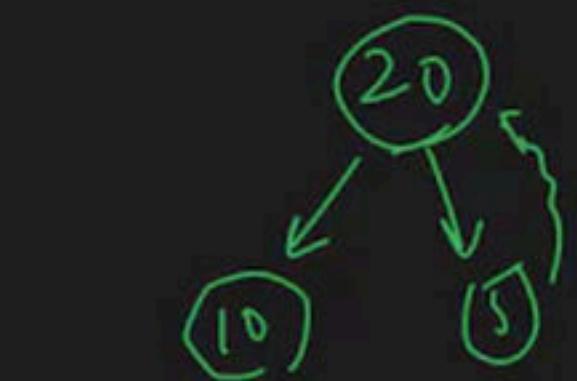
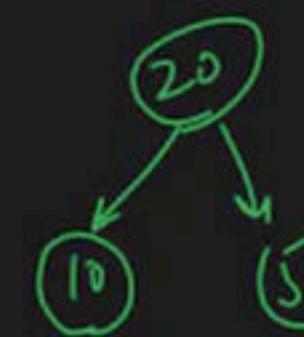
$\text{10} \rightarrow \text{hupify} \rightarrow \text{10}$



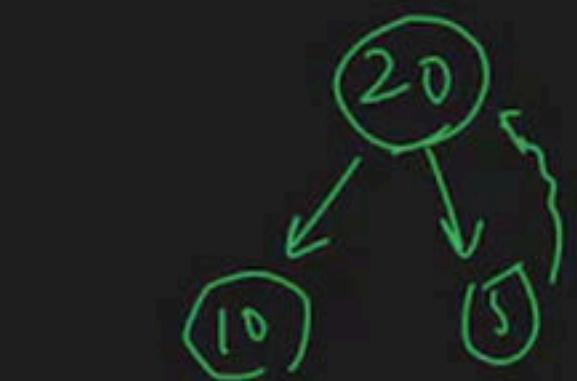
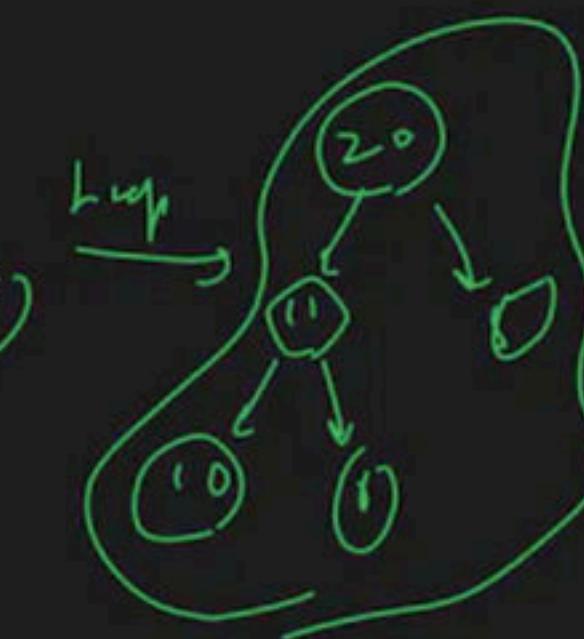
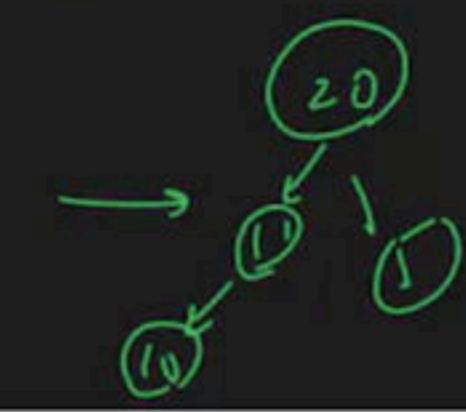
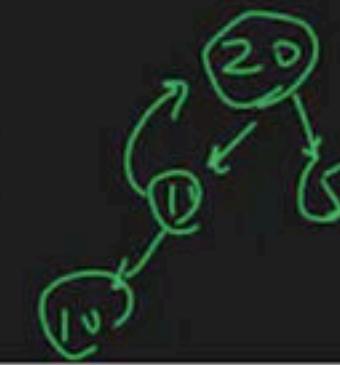
$\rightarrow \text{hupify} \rightarrow \text{20-hupify}$



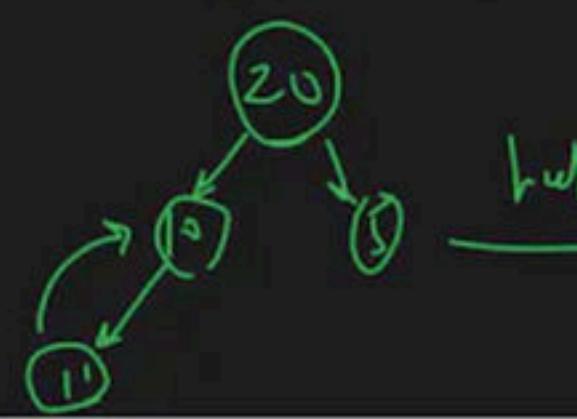
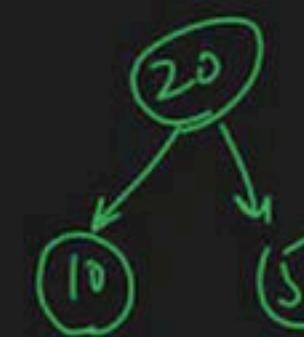
$\xrightarrow{\text{hupify}}$



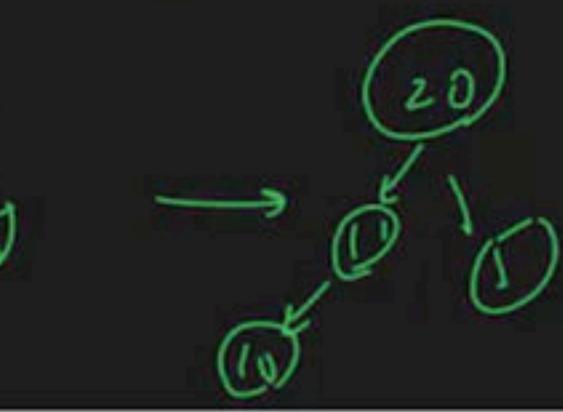
$\xrightarrow{\text{hupify}}$

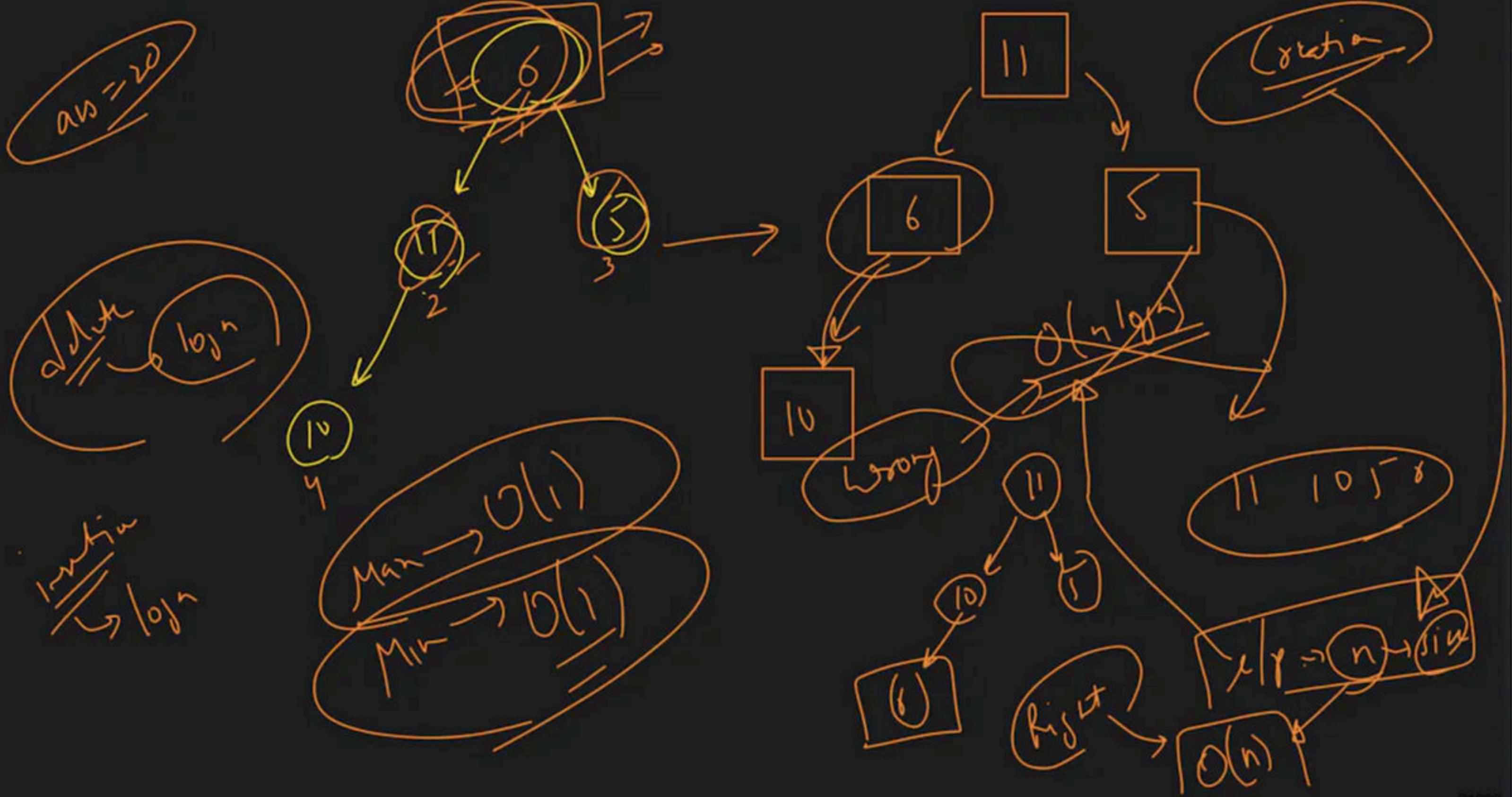


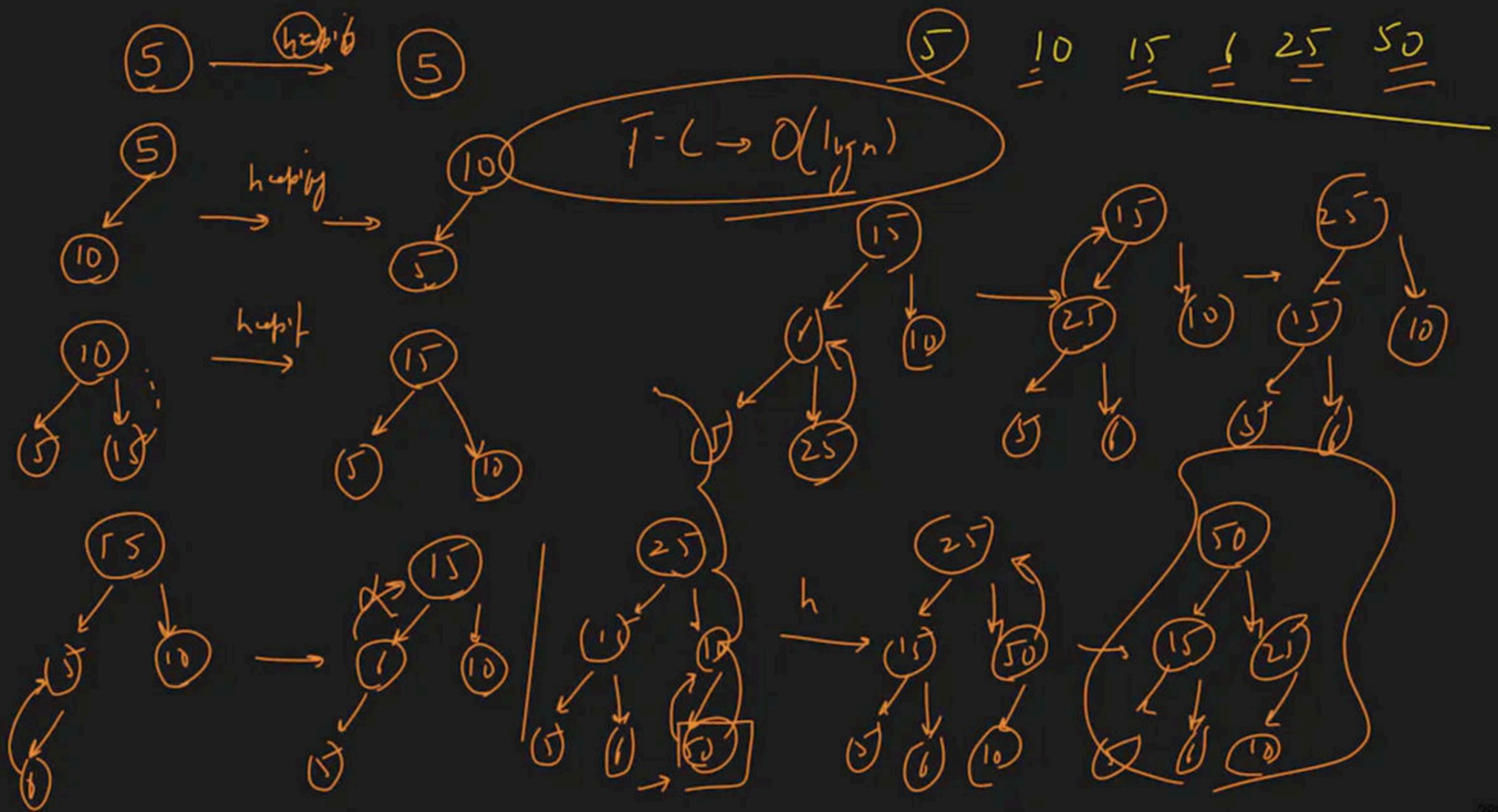
$\xrightarrow{\text{hupify}}$

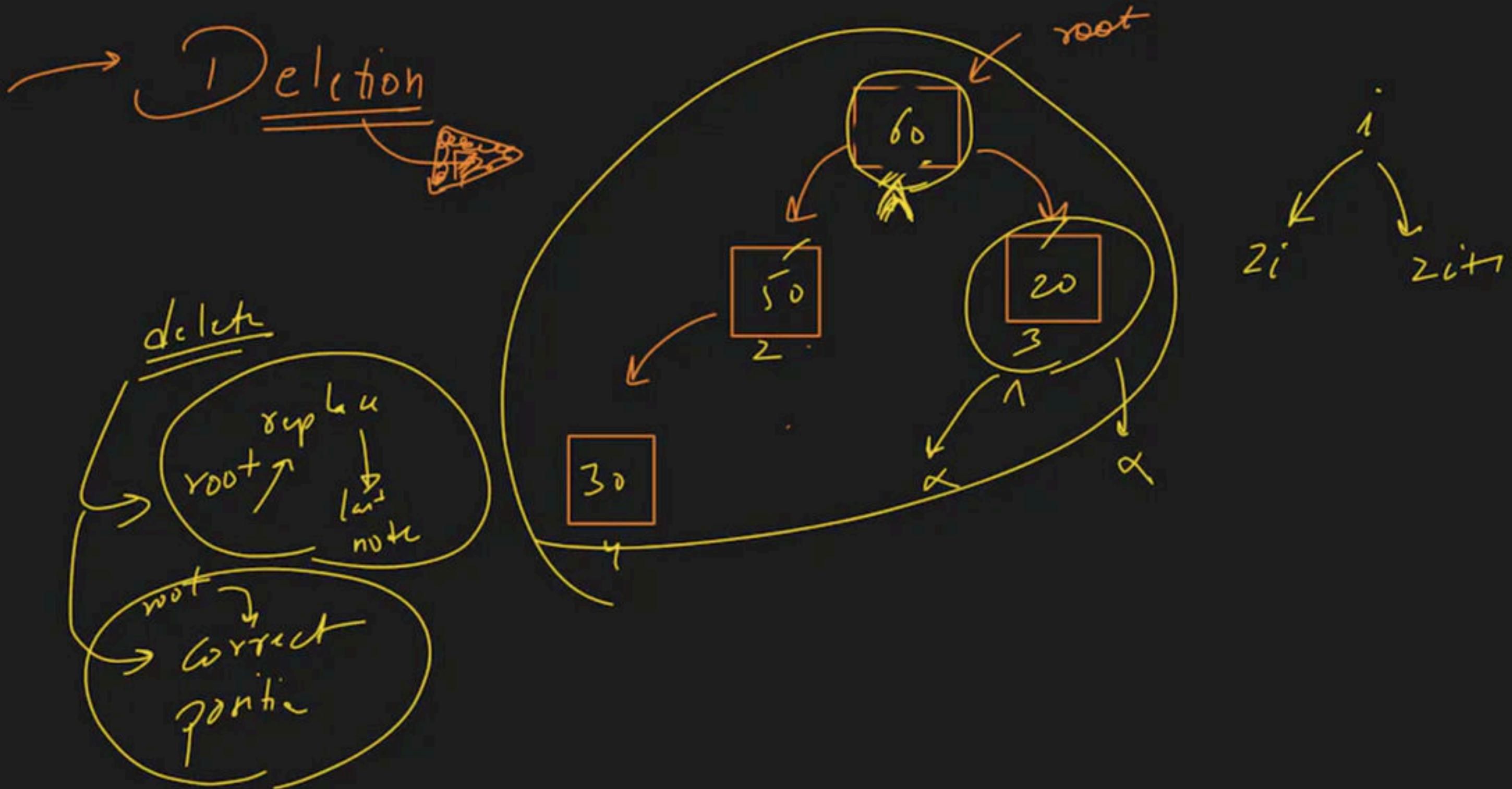


$\xrightarrow{\text{hupify}}$







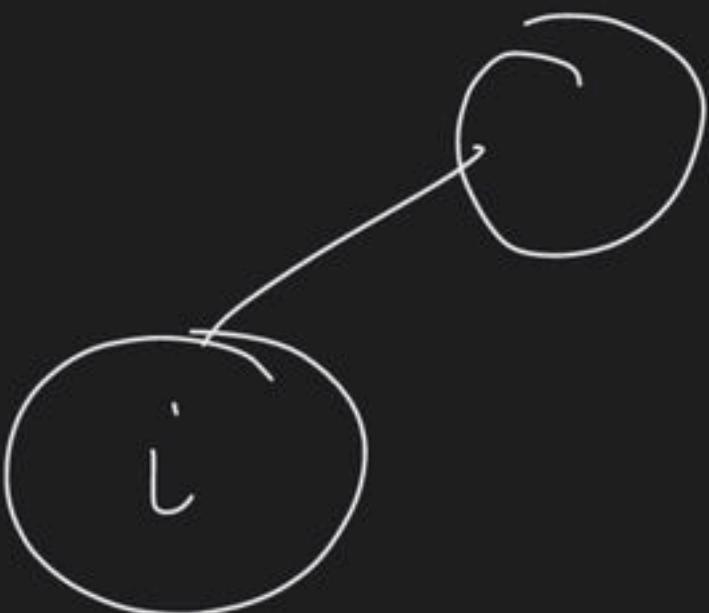


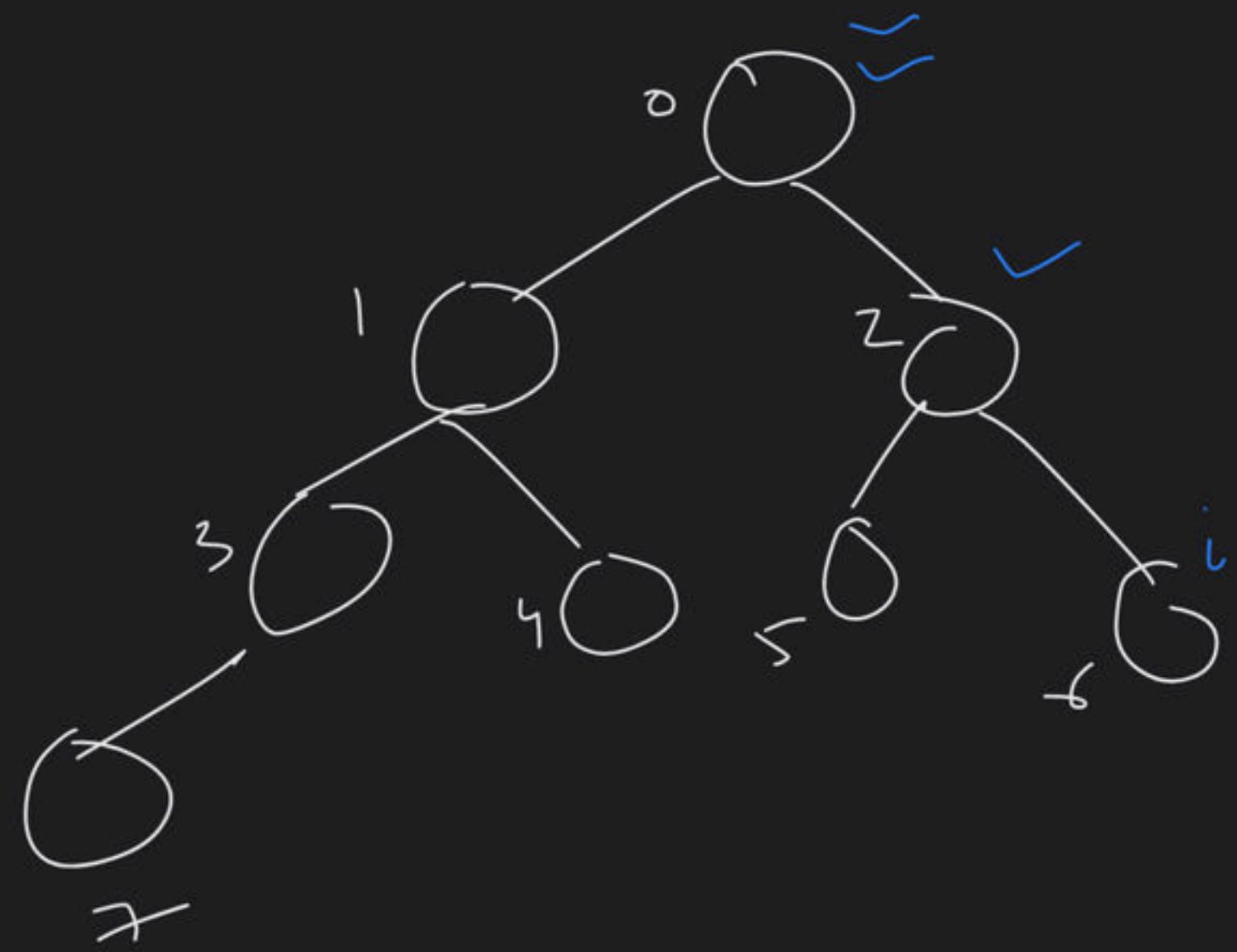
O Based \rightarrow acha $\star \star$

+ Based \rightarrow Love Babbar \star To Begin with

\Rightarrow

i Node $\rightarrow l \Rightarrow$
 $l = 2i + 1$ $2i + 2$
 \equiv



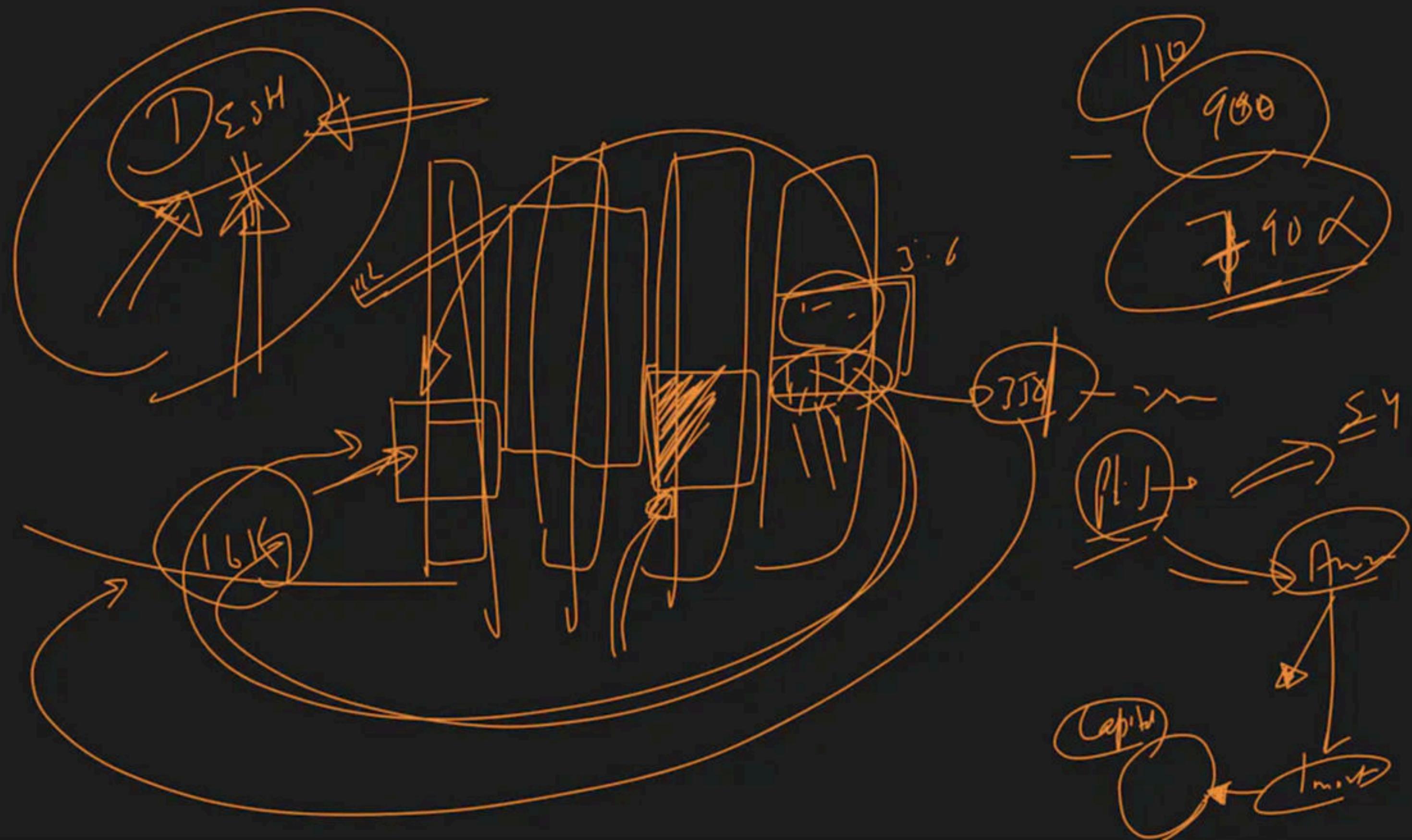


\Rightarrow

~~P~~ $\Rightarrow \frac{(i-1)}{2}$

$\frac{1-1}{2}$

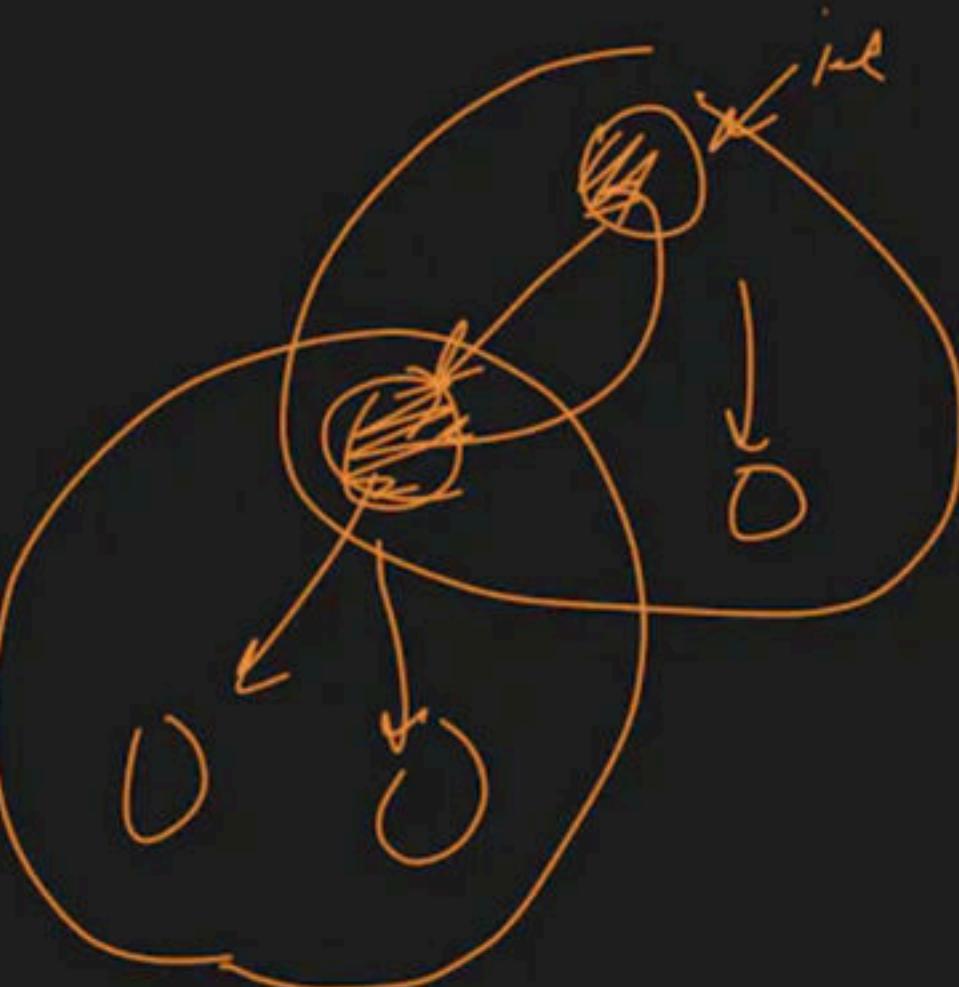
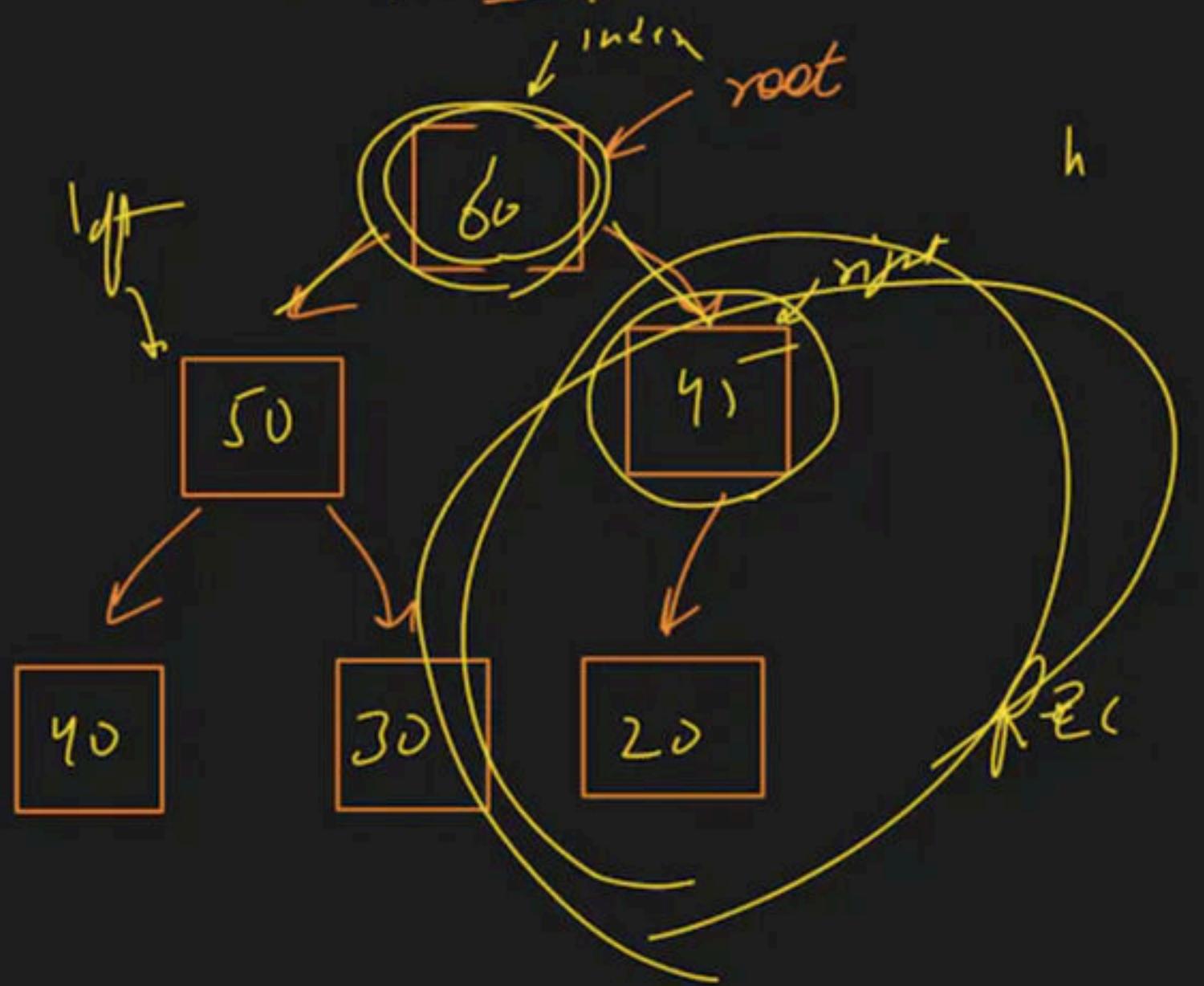
$\frac{2-1}{2}$

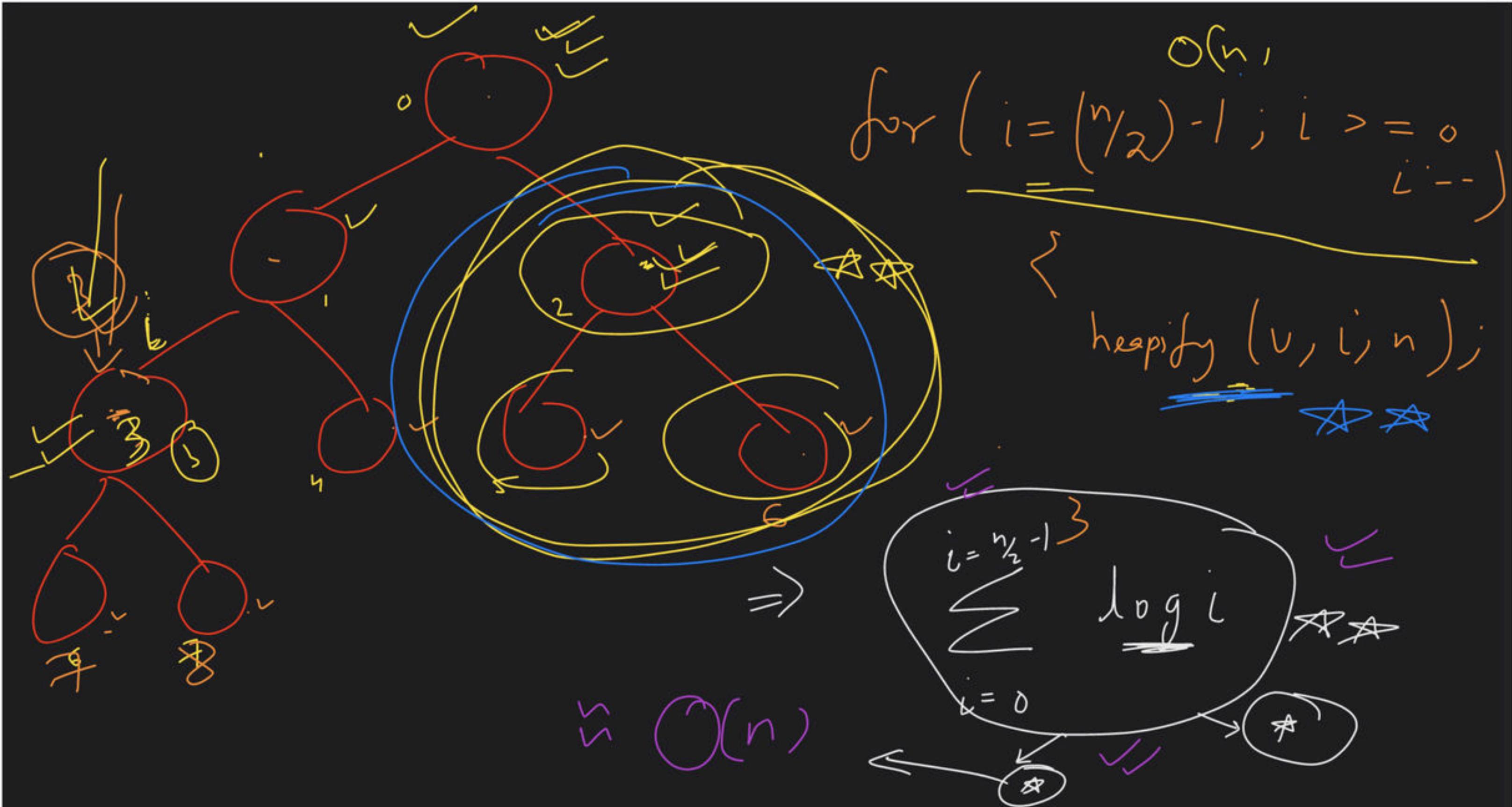


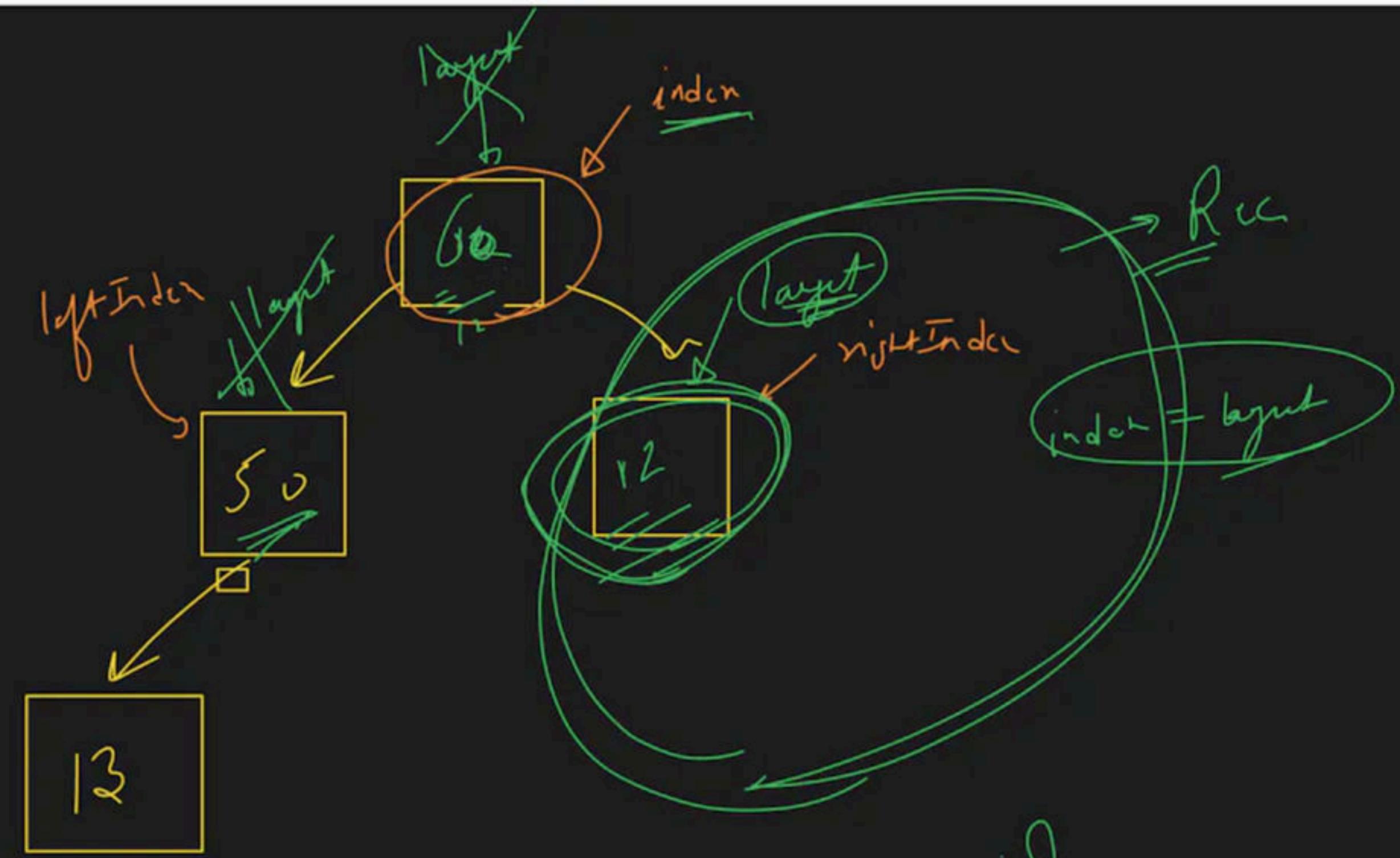
Uishad

Dachig

~~heapsify [arr, n, index]~~

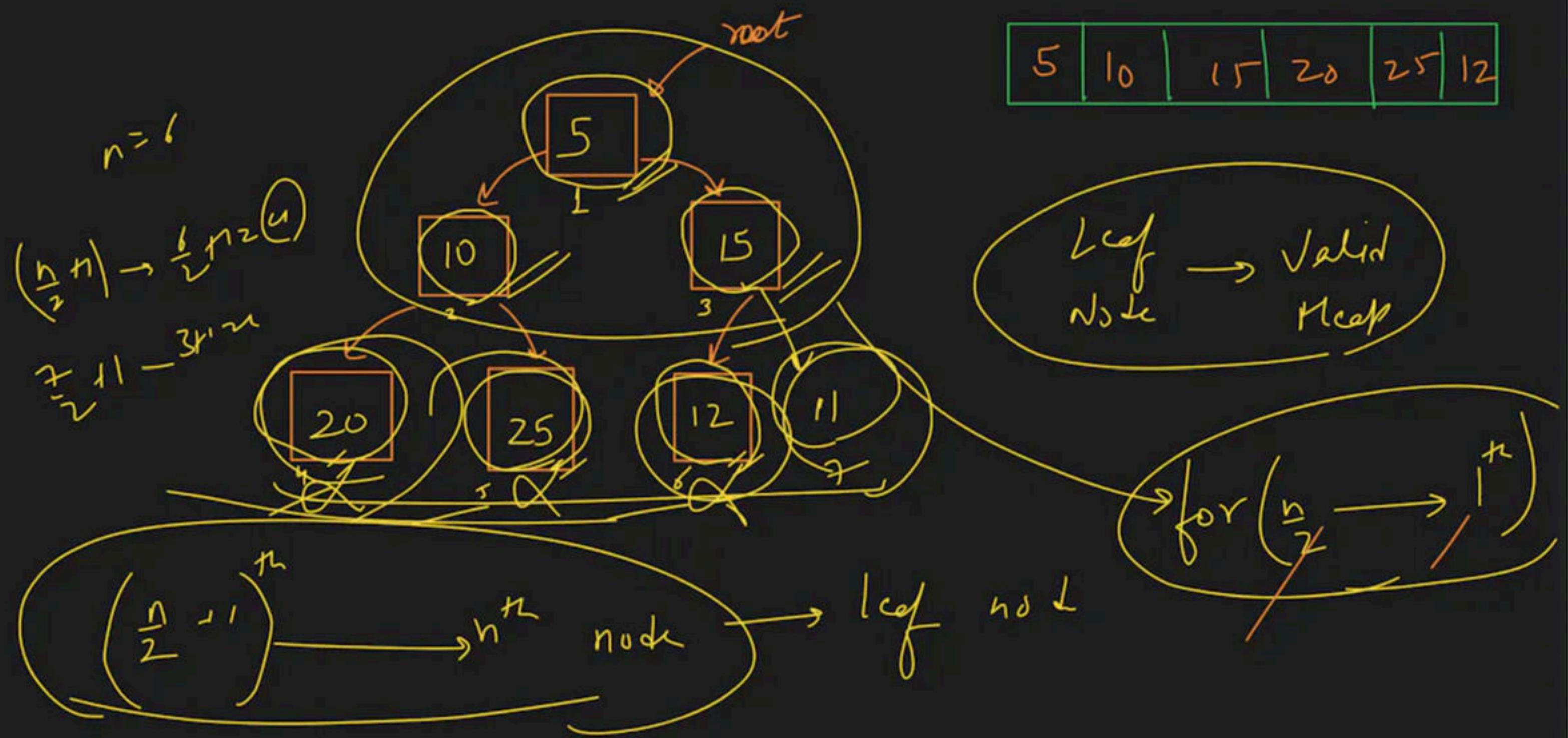


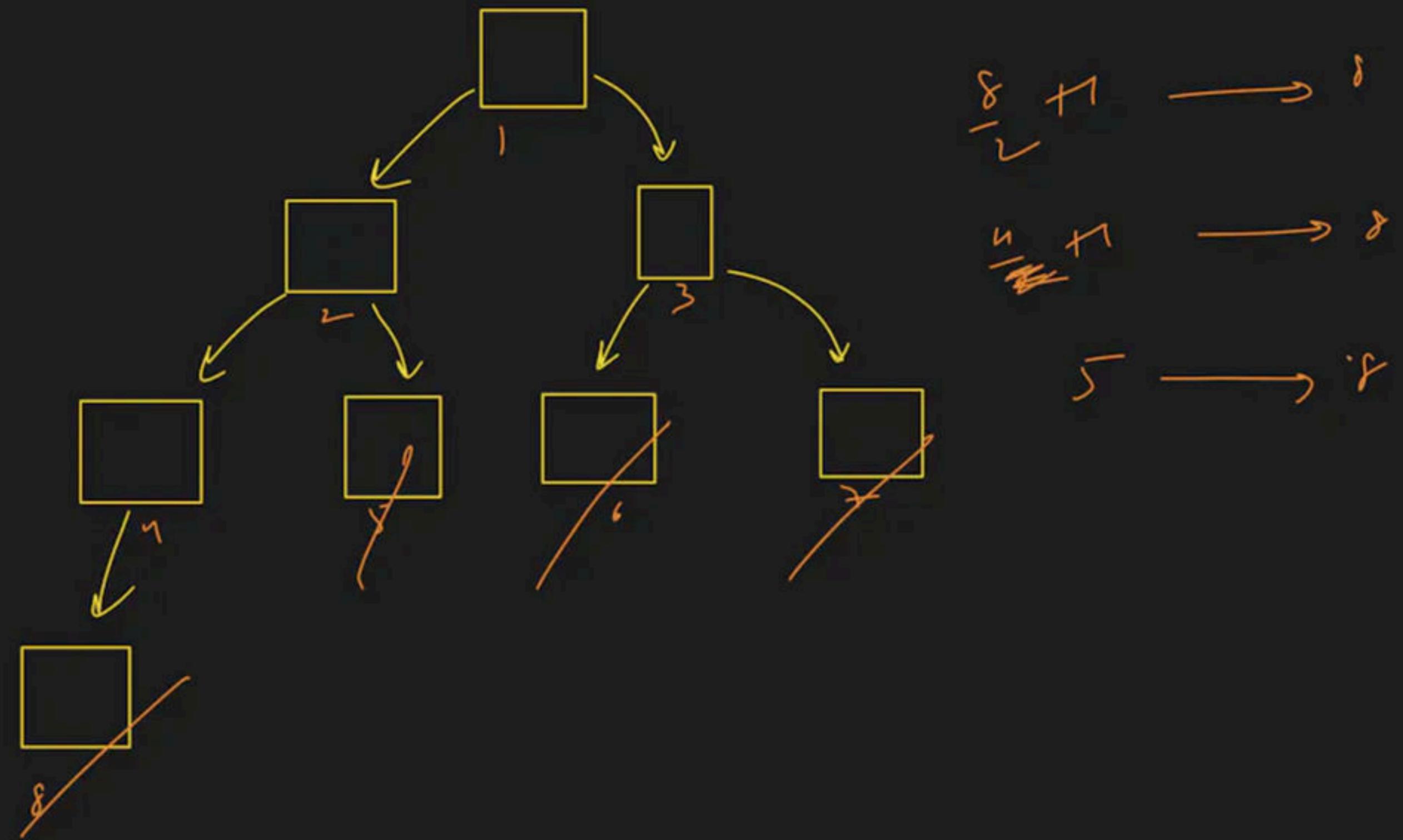


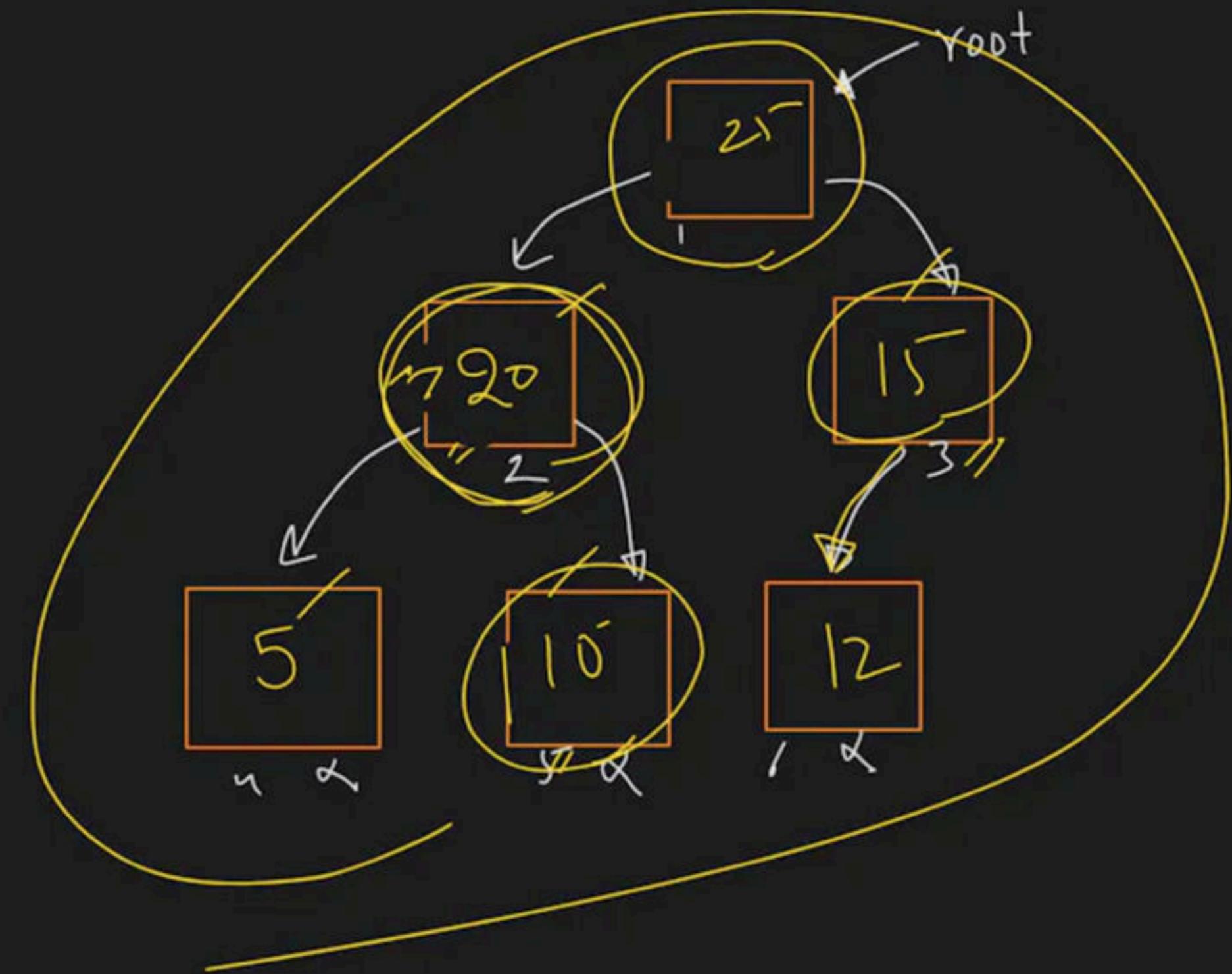


$left_int = ? \oplus i$?

5	10	15	20	25	12
---	----	----	----	----	----

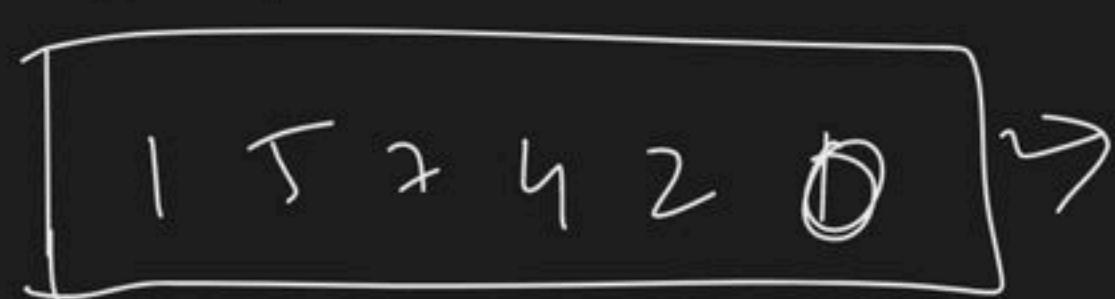
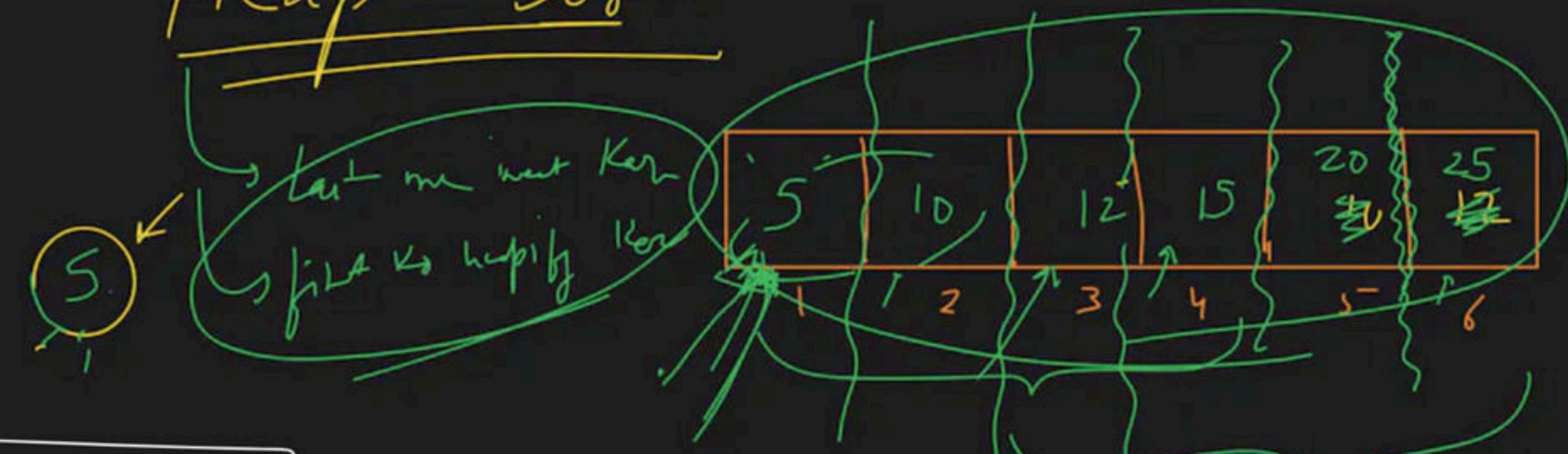




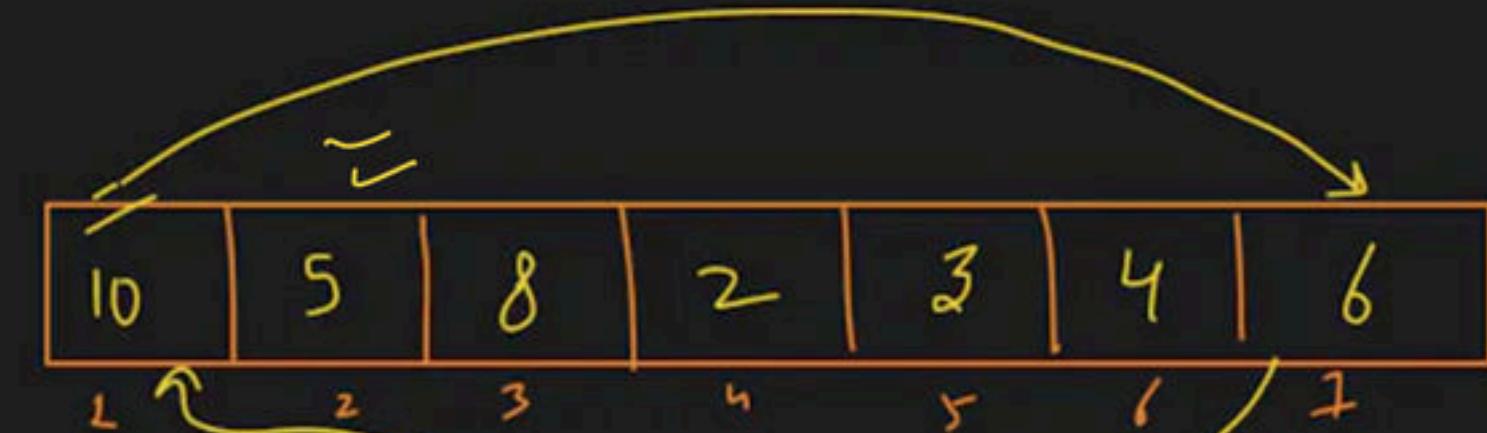
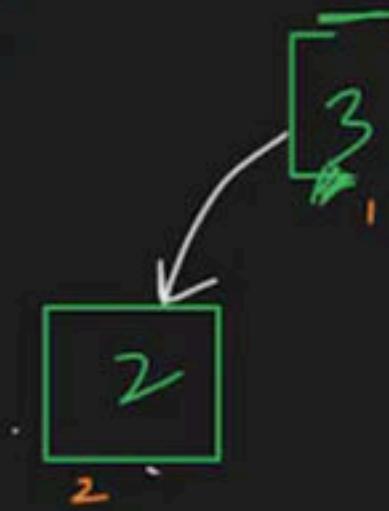


$L \cdot N \rightarrow \frac{5}{2} + 1 \rightarrow h$
 $\frac{6}{2} + 1 \rightarrow f$
 $7 \cdot h \rightarrow s$
 $\text{for } (2 \rightarrow \cdot)$
 $\text{for } (\frac{1}{2} \rightarrow 1)$
 $\text{for } (3 \rightarrow 1)$

~~Map~~ ~~Sort~~



Dyfun



8, 5, 6, 2, 3, 4 } 10
sorted

6, 5, 4, 2, 3, 1 } 8, 10
unsorted

5, 3, 4, 2, 1 } 6, 8, 10
sorted

4, 3, 2, 1 } 5, 1, 8, 10
unsorted

3, 2, 1 } 4, 5, 1, 8, 10
sorted

2 } 3, 4, 5, 1, 1, 10, 0, 0, 0
unsorted

1, 3, 4, 5, 6, 1, 1, 10

←

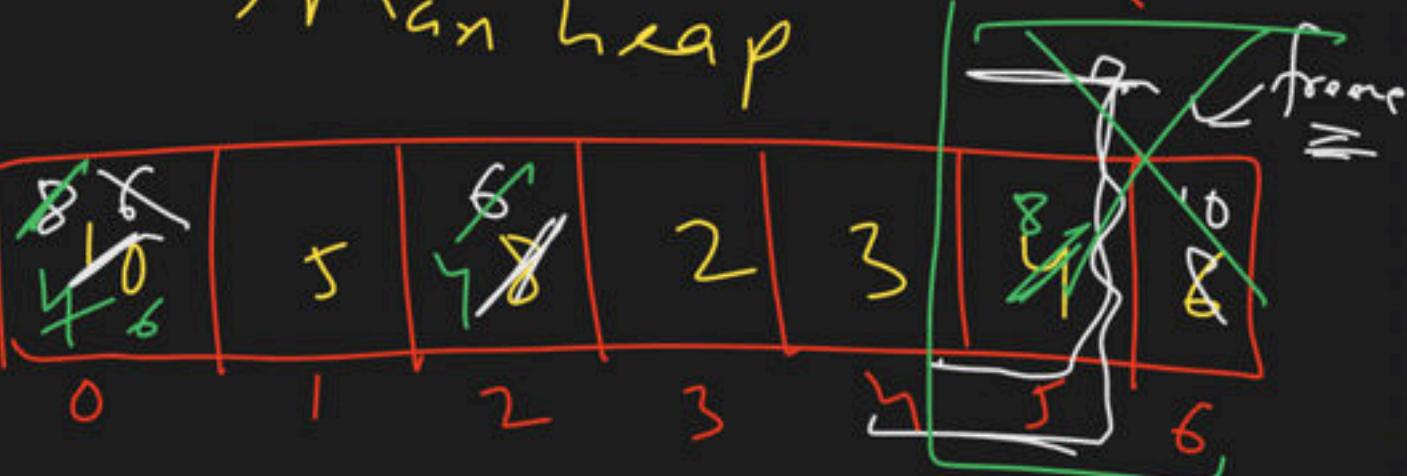
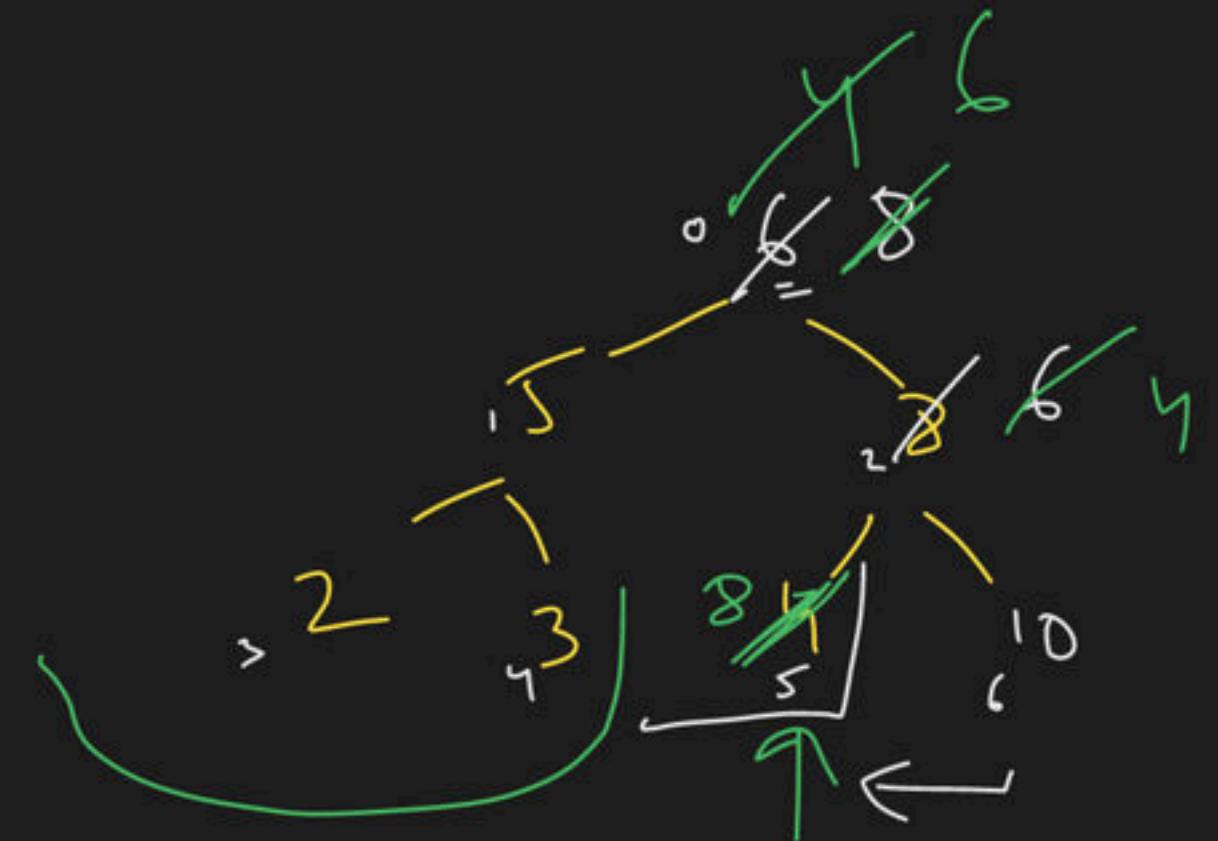
2

\Rightarrow

$N = 7$

①

Build array into heap $\rightarrow O(n)$



$$\text{int } n = N - 1 \Rightarrow n = 6$$

① swap ($\text{num}[0], \text{num}[n]$)
 $n--$
 $\leftarrow \text{heapsift} (\text{num}, 0, n)$

Heaps Class - 2

Special class

Heap → BT + Heap Property

①

priority-queue

int, char, bool

Prm-Que<int> pq ✓

Prm-Que<int, vector<int>> pq ✓

Basic " " <int, vector<int>, greater<int> > pq ✓

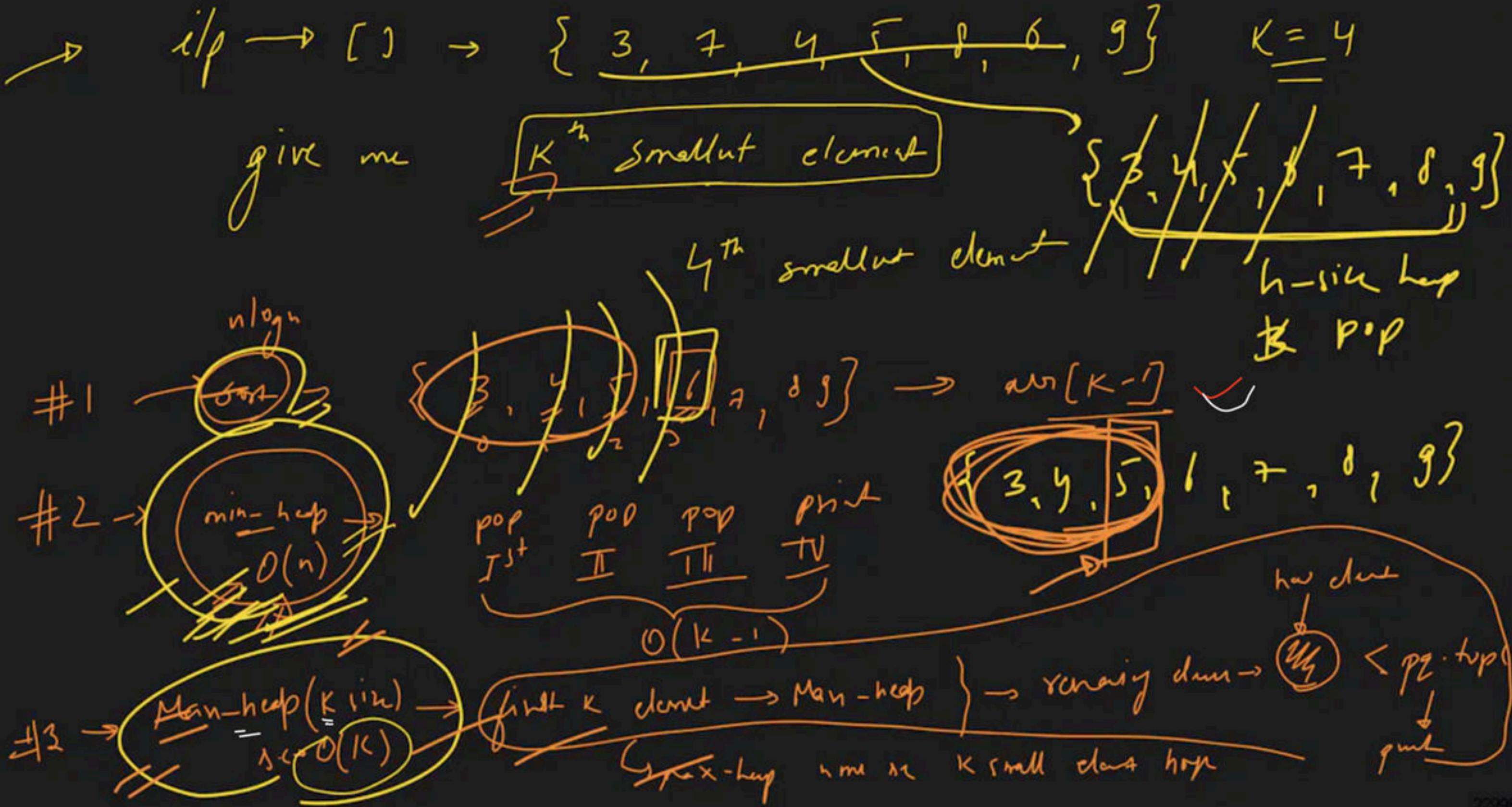
Min heap.

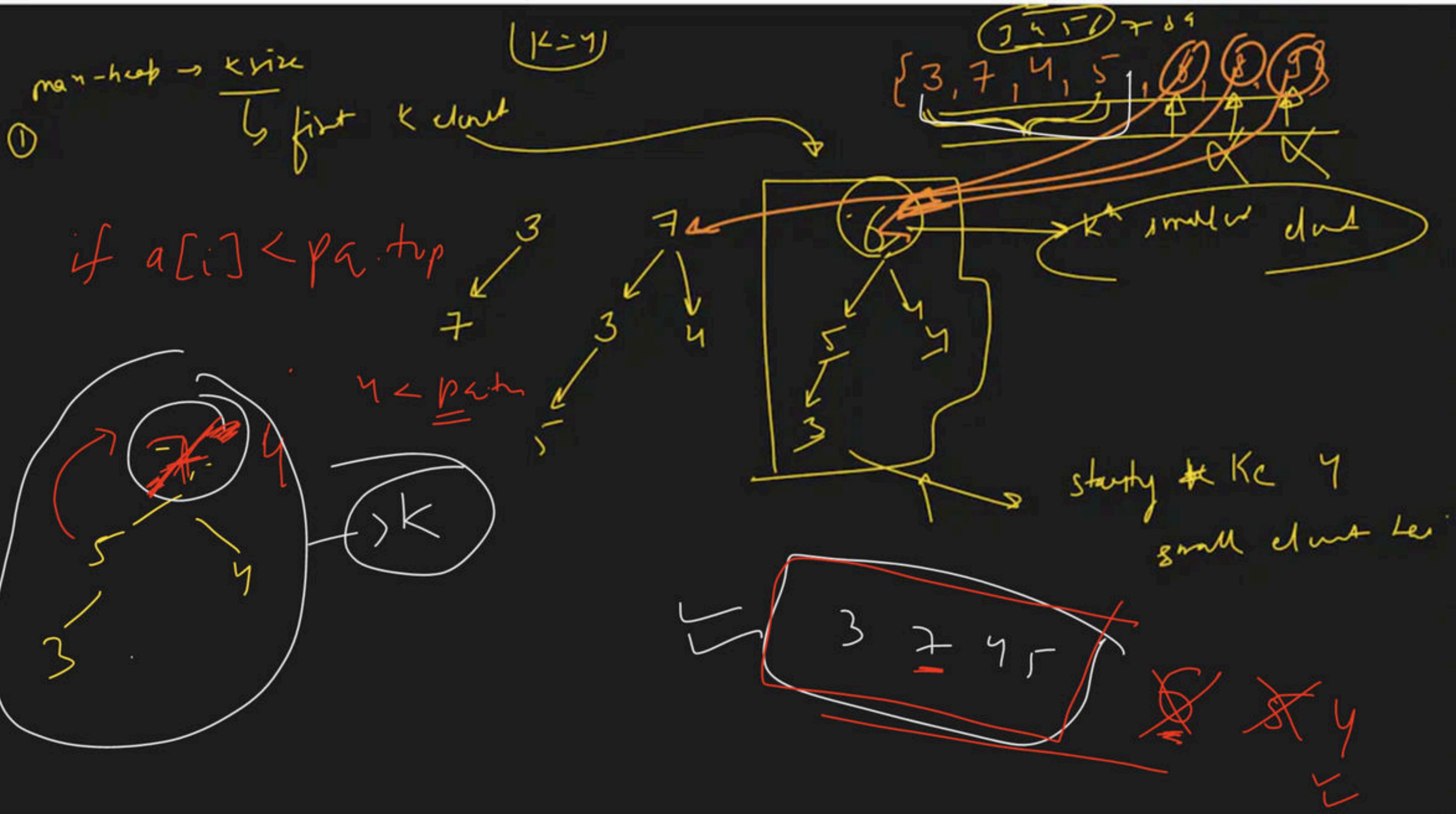
Priority-Queue<d-type, vector<d-type>, Comp> > pq

```
class comp {  
public:  
    bool operator< ( d-type a , d-type b ) {  
        <  
        return a.val > b.val ;  
    } ;  
}
```

Sort → Comp →

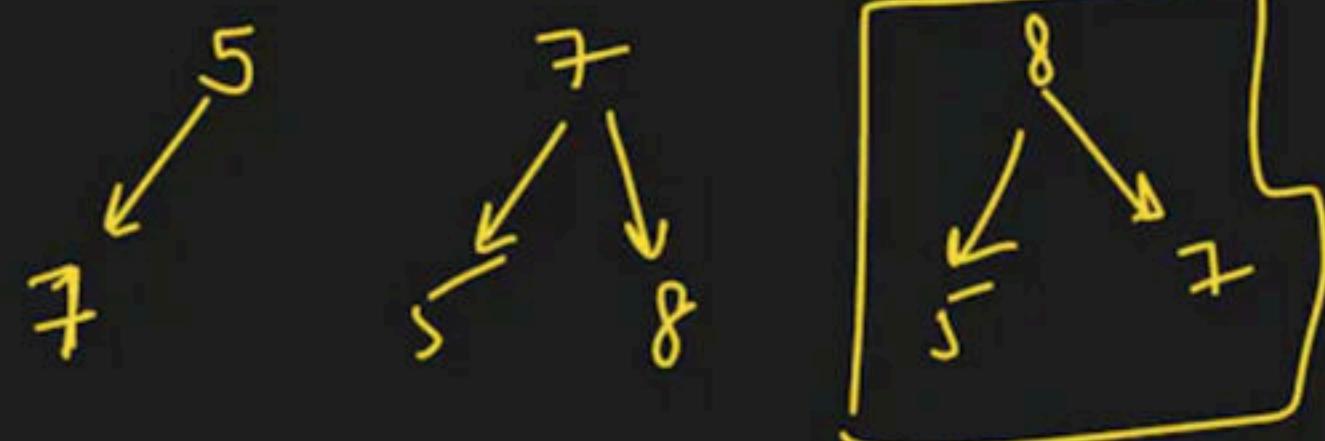
a > b ↳ ☆ ↴



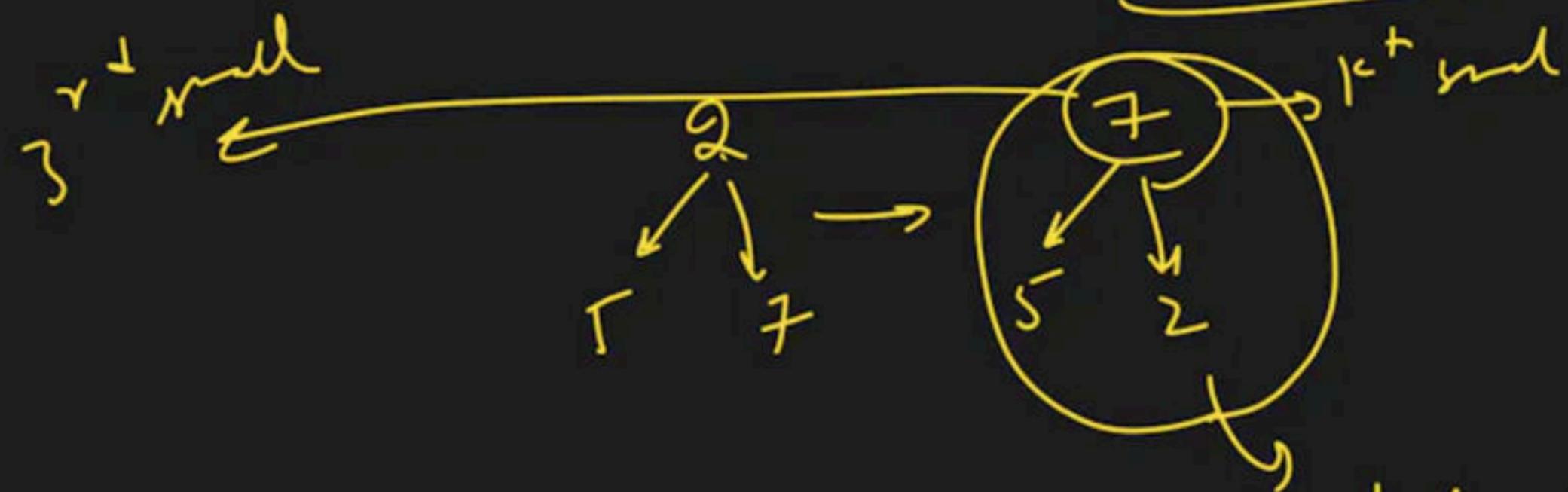


(5)

first cloud process know



{ 1, 7, 8, 5 } , { 12, P, 9 }
 $k = 3$
2, P, 8, 5, 12



12 < 8 ✗

2 < 8 =

9 < 7 ✗

start $k \cdot 3$ small
L'

$-n^2$

(2)

\downarrow

n^3

z^3

δ

\rightarrow BT \longrightarrow is Valid Min Heap or not

$\text{BT} \rightarrow \text{Min heap?}$

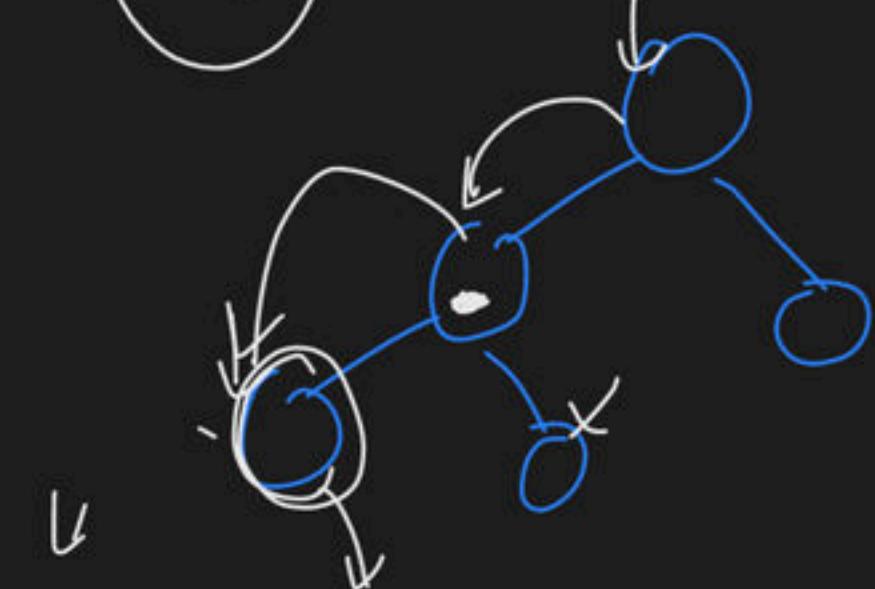
$\text{Map} \rightarrow$

~~$\text{BT} + \text{Map}$~~

① BT

②

Min Heap property



LRN

Post order

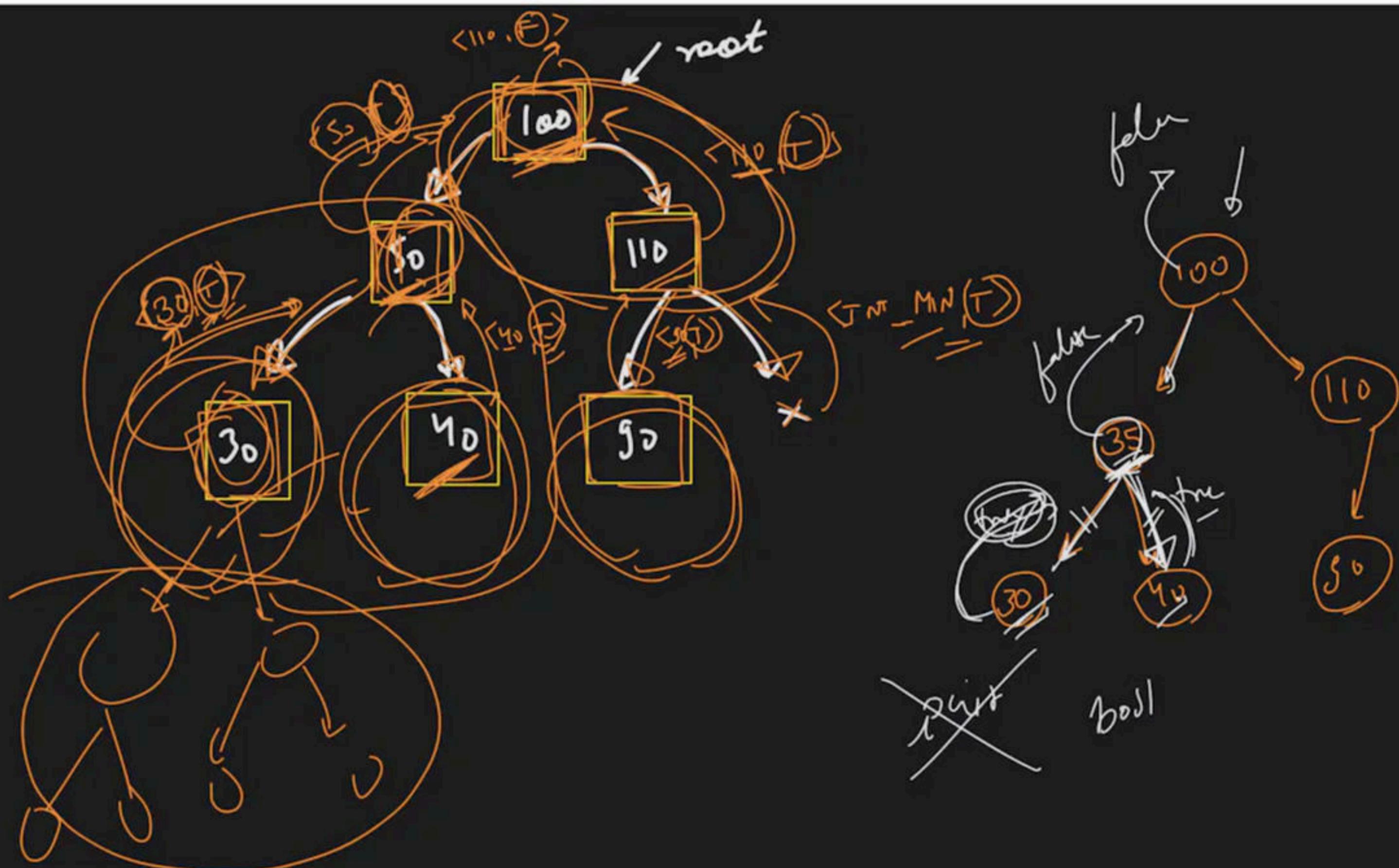
$P > C_1$
 $P > C_2$



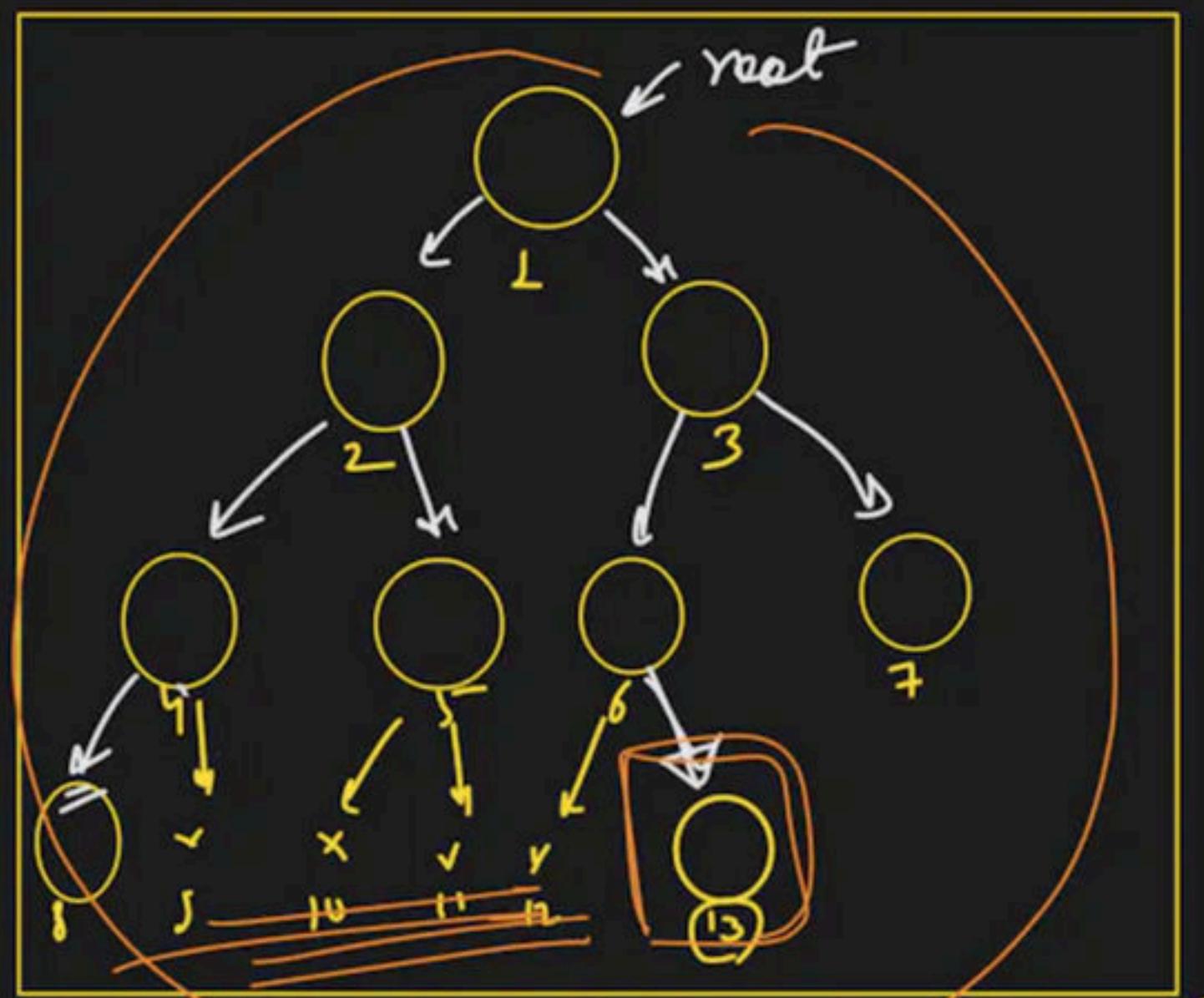
$\langle x, y \rangle \rightarrow T/F$
 max value of subtree
 Subtree's valid max-hgap
 $0 \sim 70^+$

\rightarrow left subtree \rightarrow True \rightarrow Hgap
 \rightarrow right subtree \rightarrow True \rightarrow Sgap } Valid Hgap

$\rightarrow 10 > 5 \rightarrow$ True
 $\rightarrow 10 > ENT_MIN \rightarrow$ True



whether a CBT or not

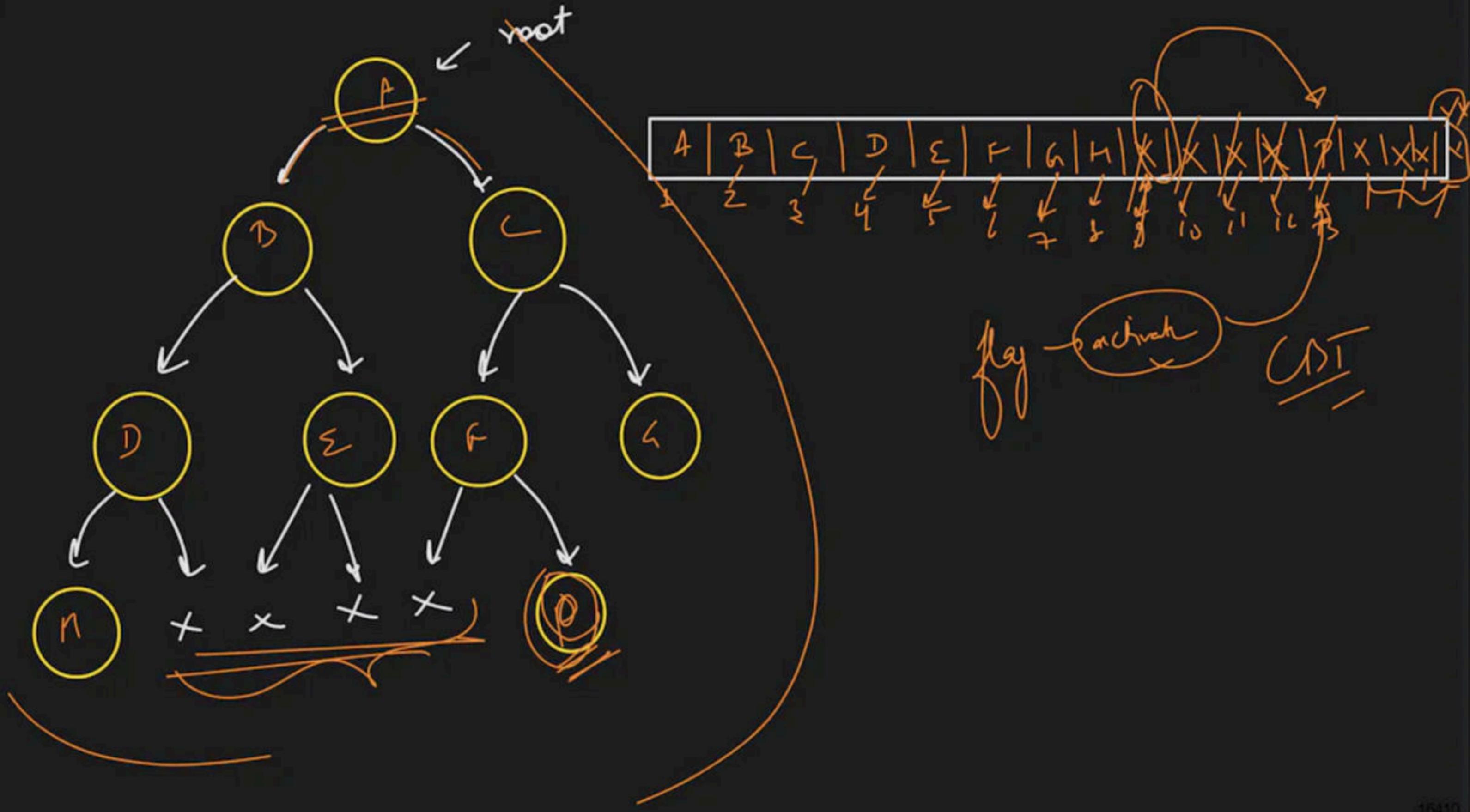


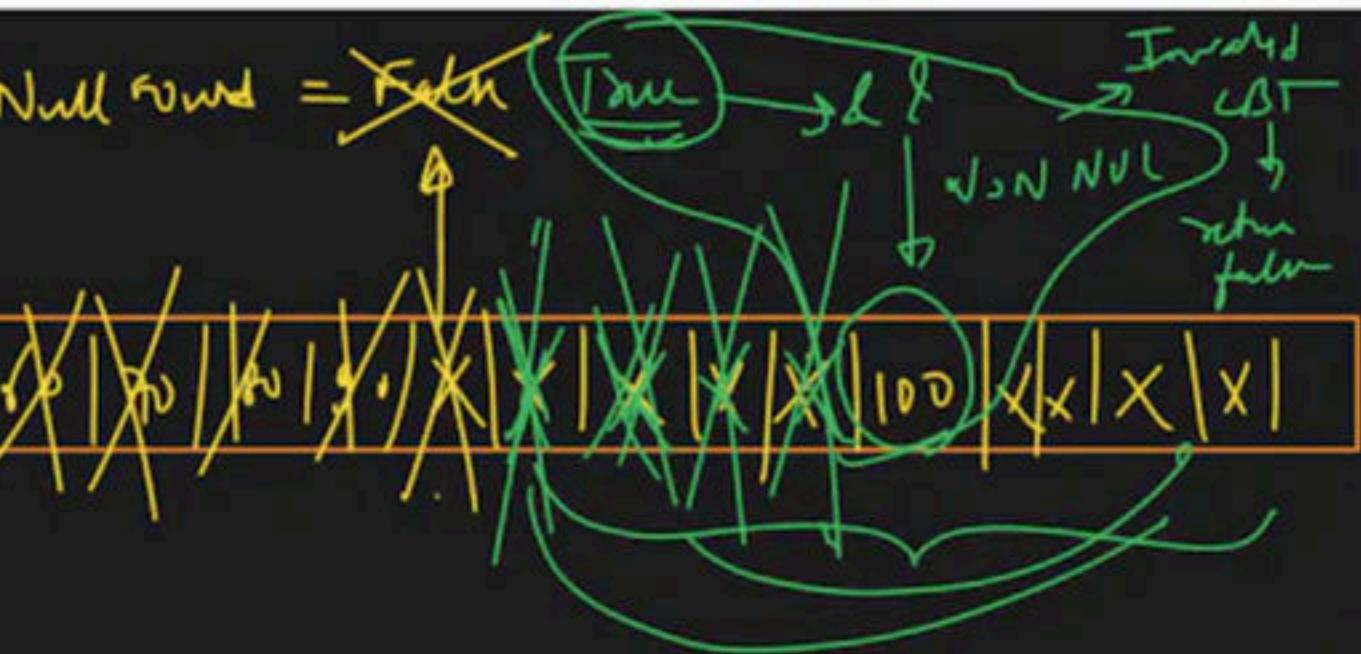
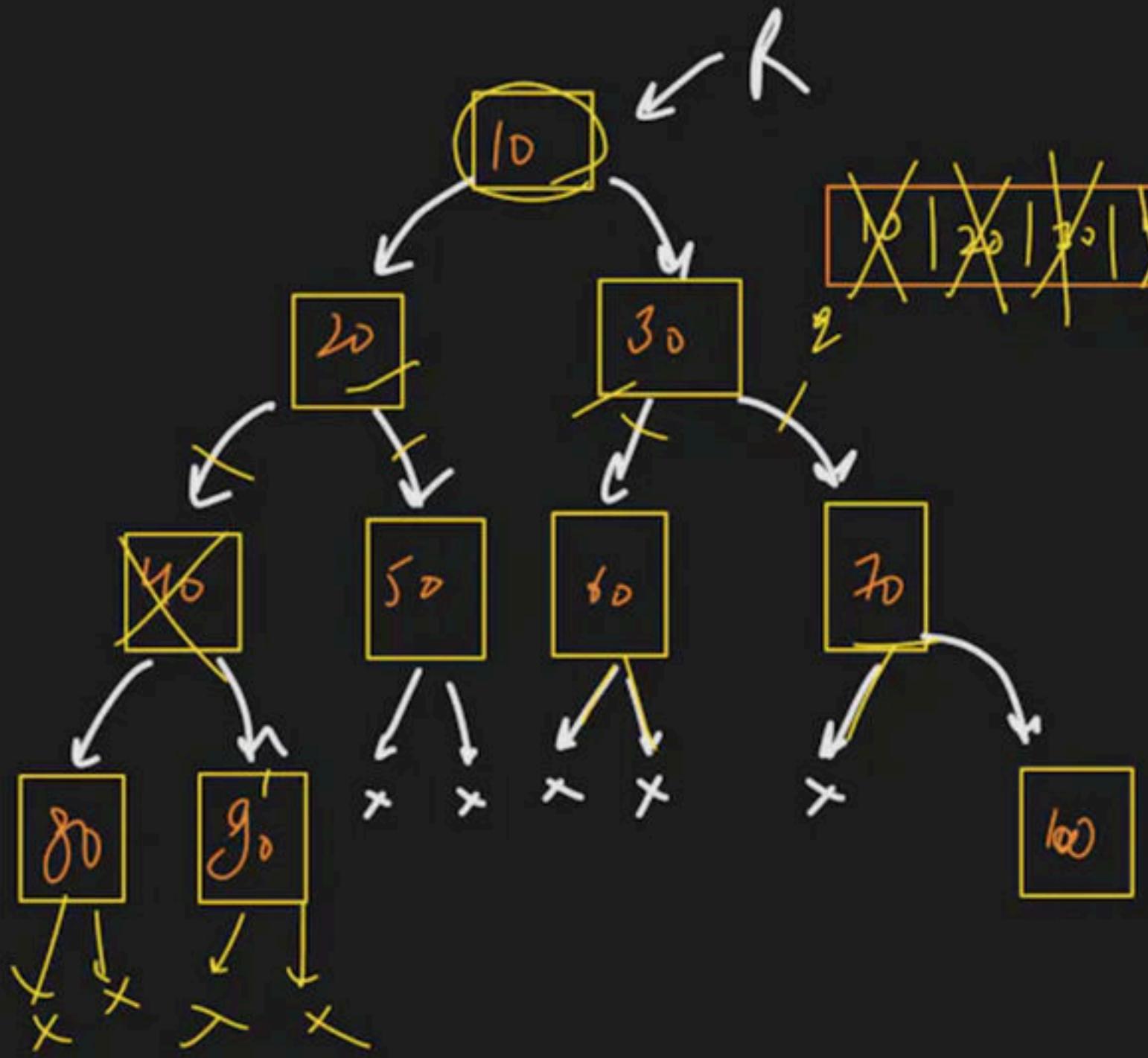
left
Node → 13

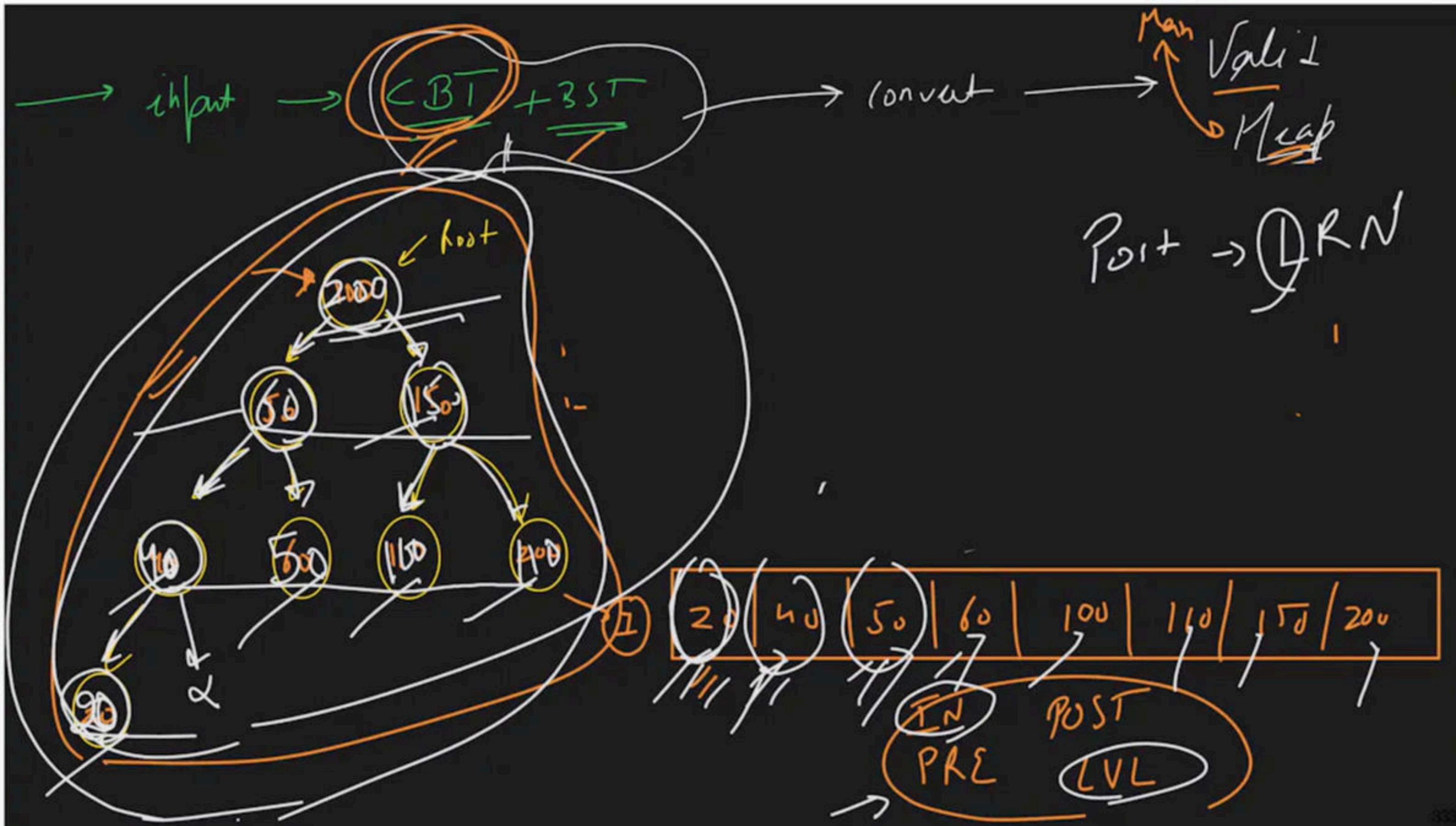
Total
Node = 9

left node > total node

Not a CBT

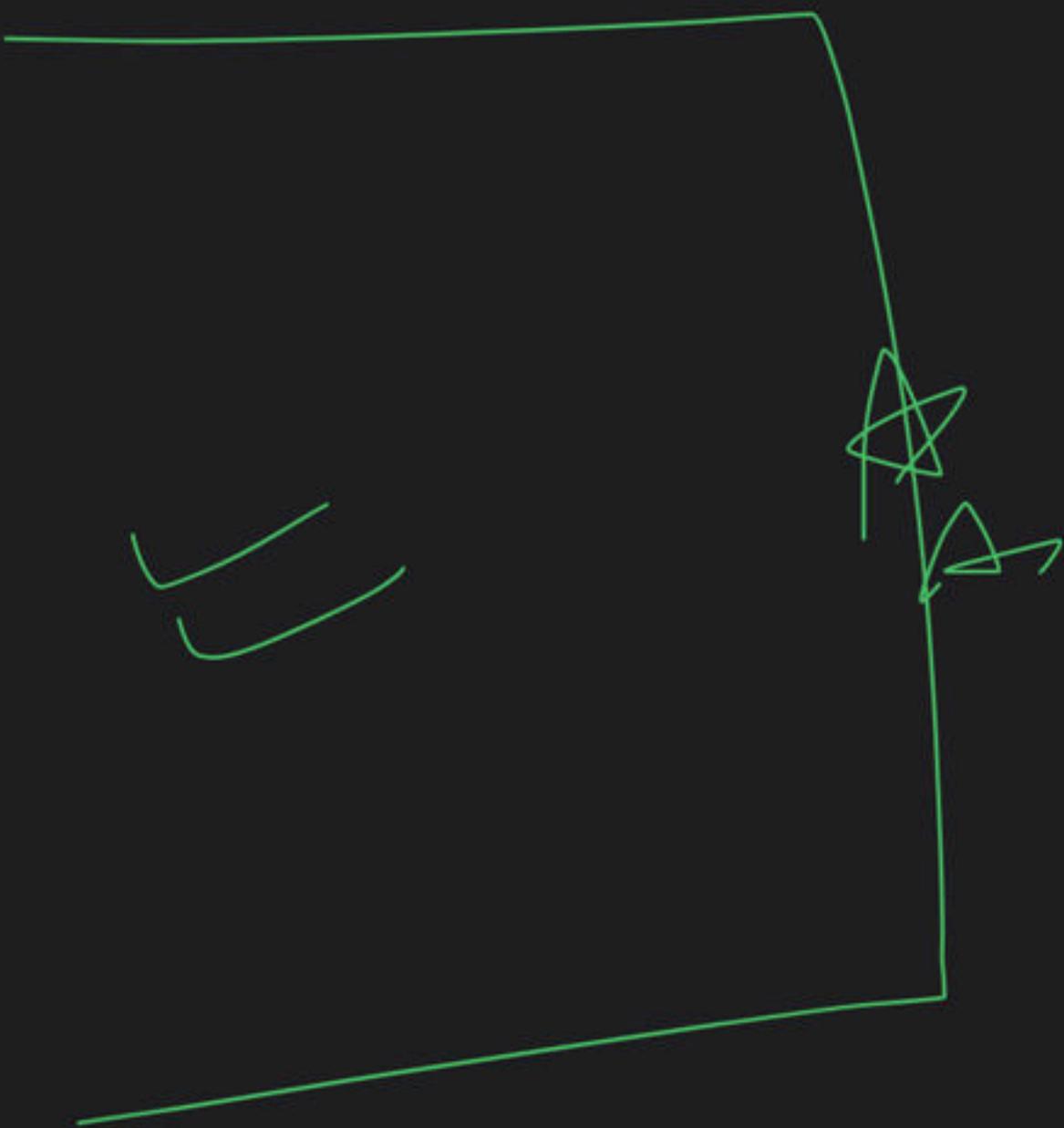






Min heap from
 CBT & BST

- ① IN ORDER
- ② NLR \rightarrow full Tree ✓
 - \hookrightarrow Preorder =

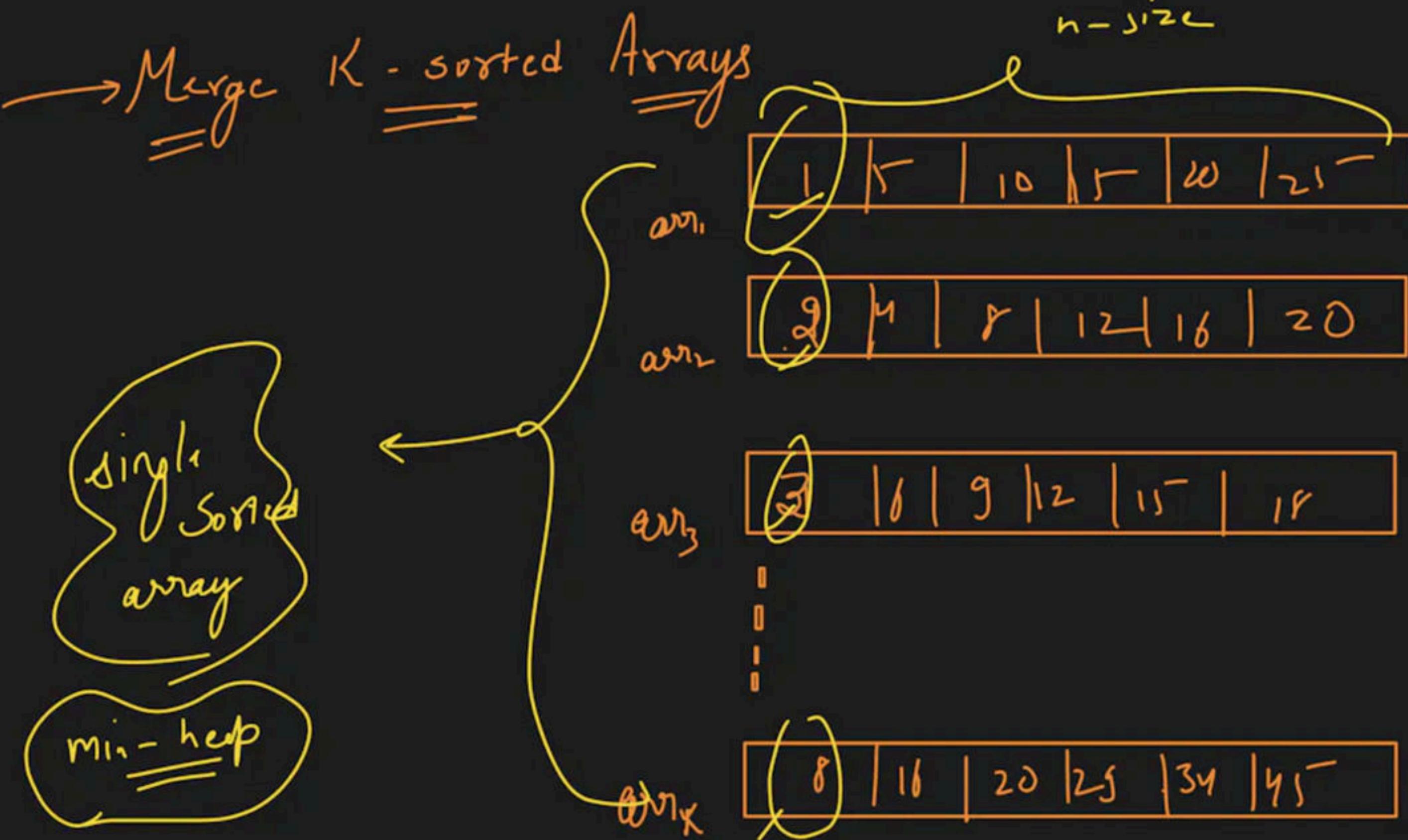




Heaps Class-3

Special class

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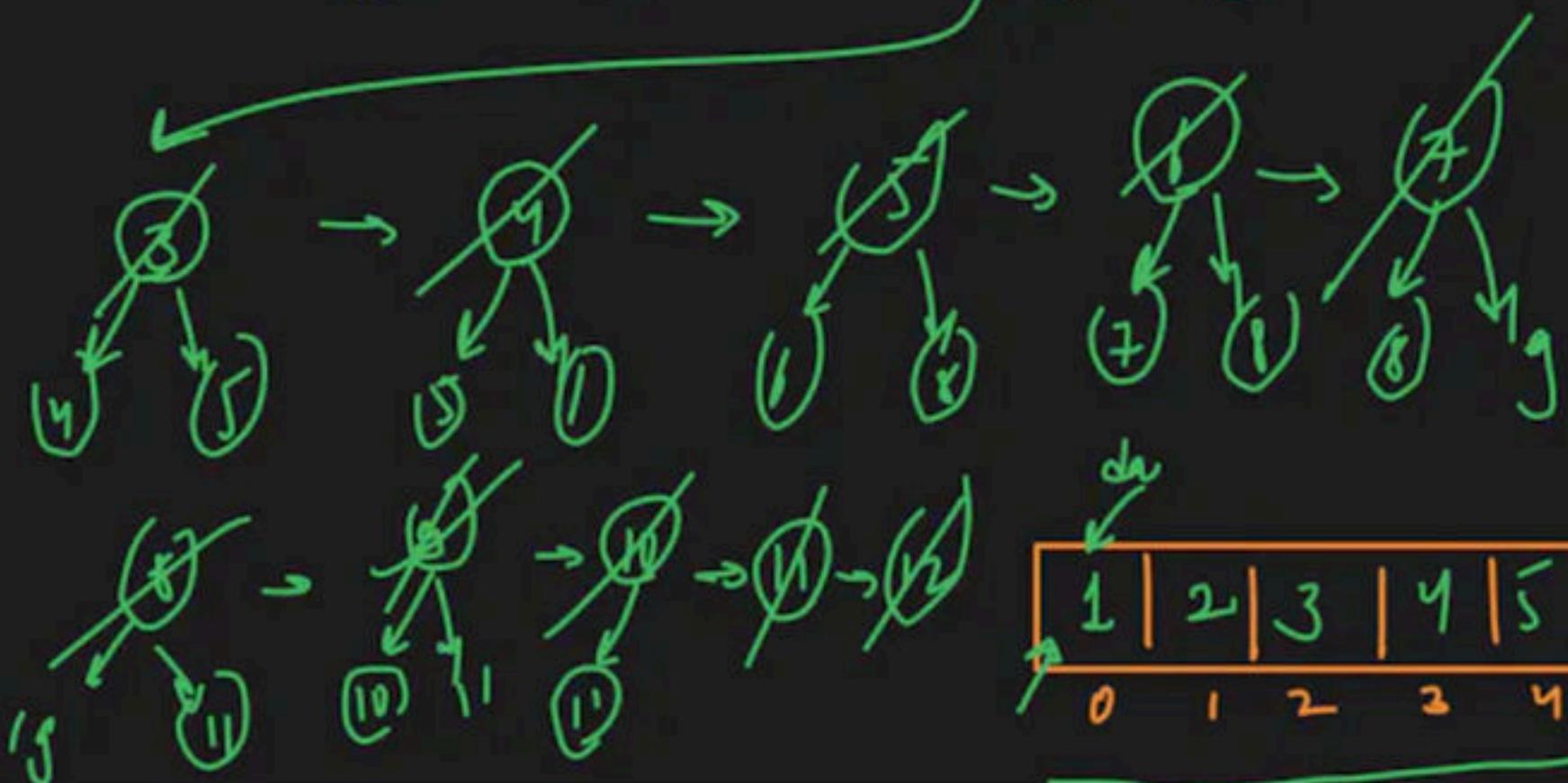
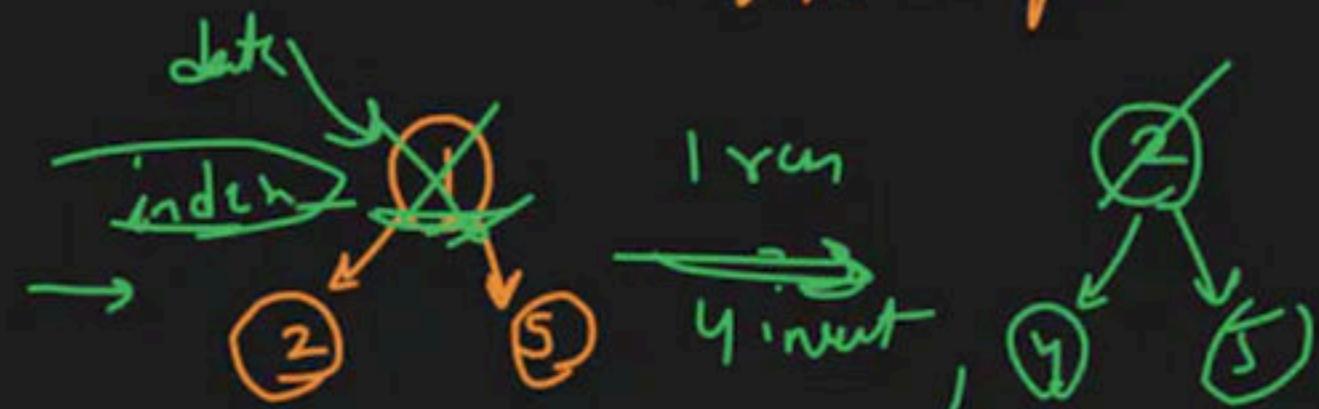


\Rightarrow Algo:

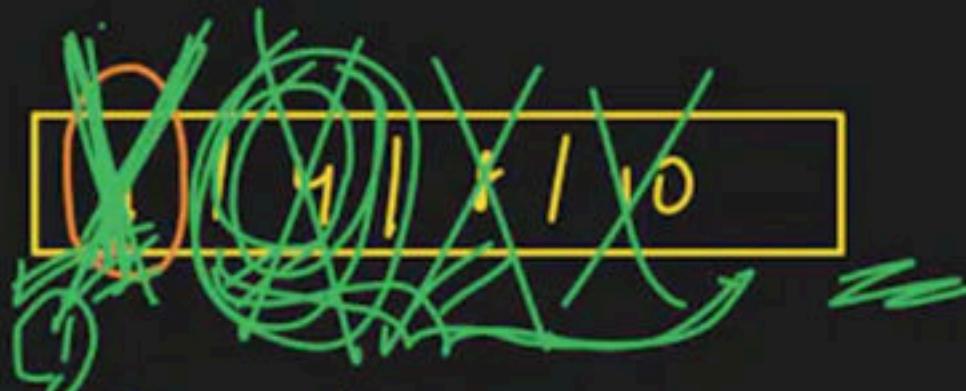
1

first element of K-array

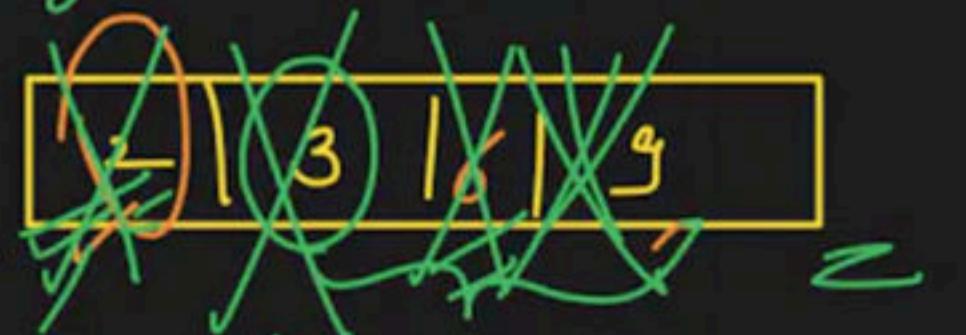
mini-heap



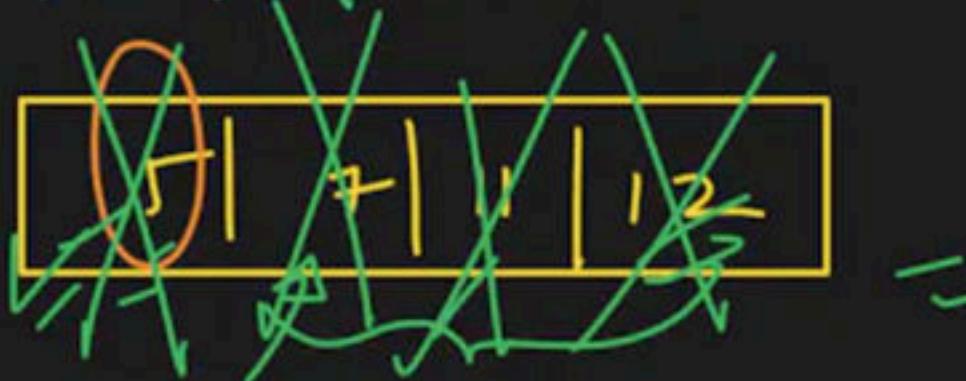
arr.



arr_2

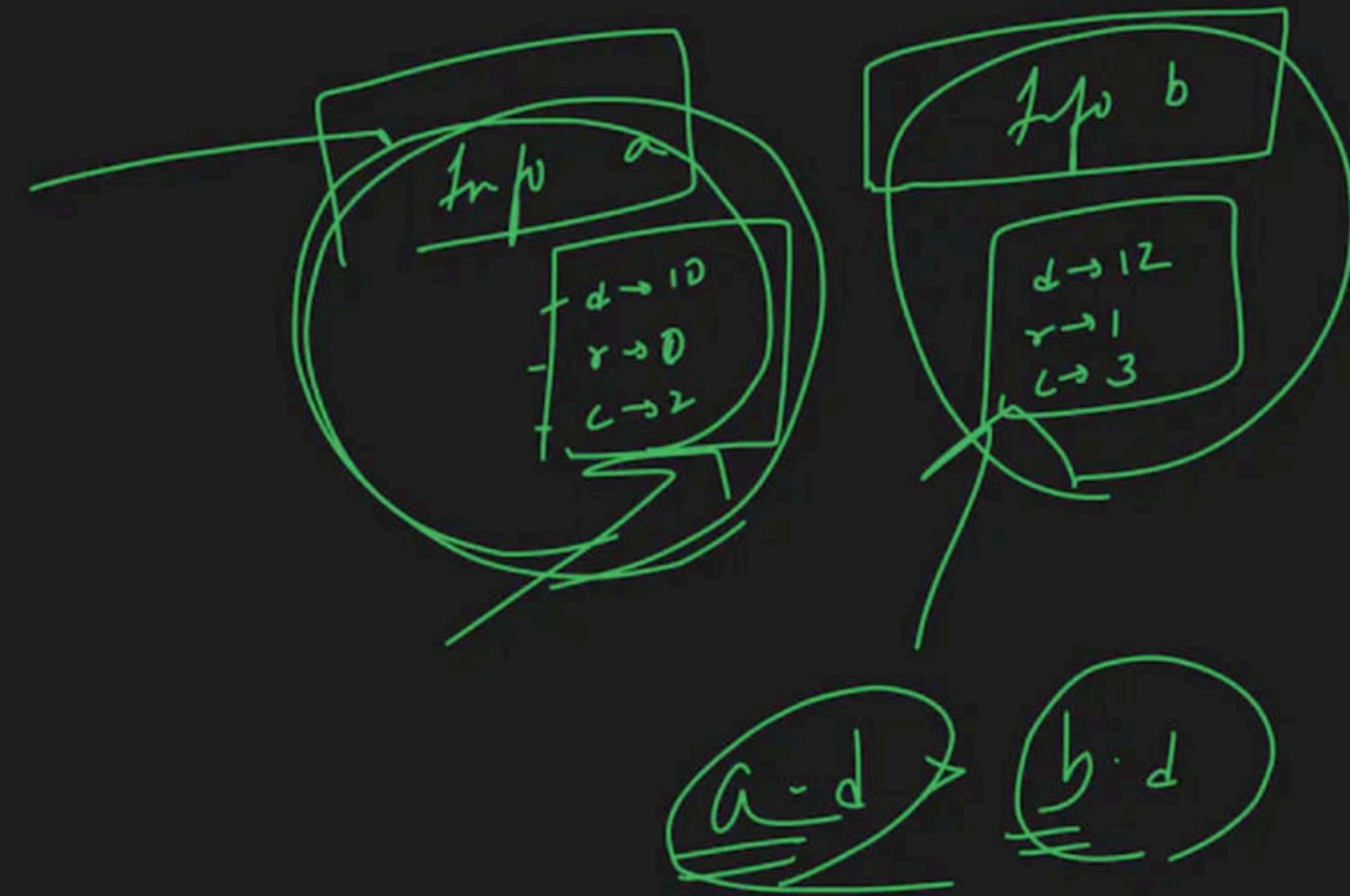


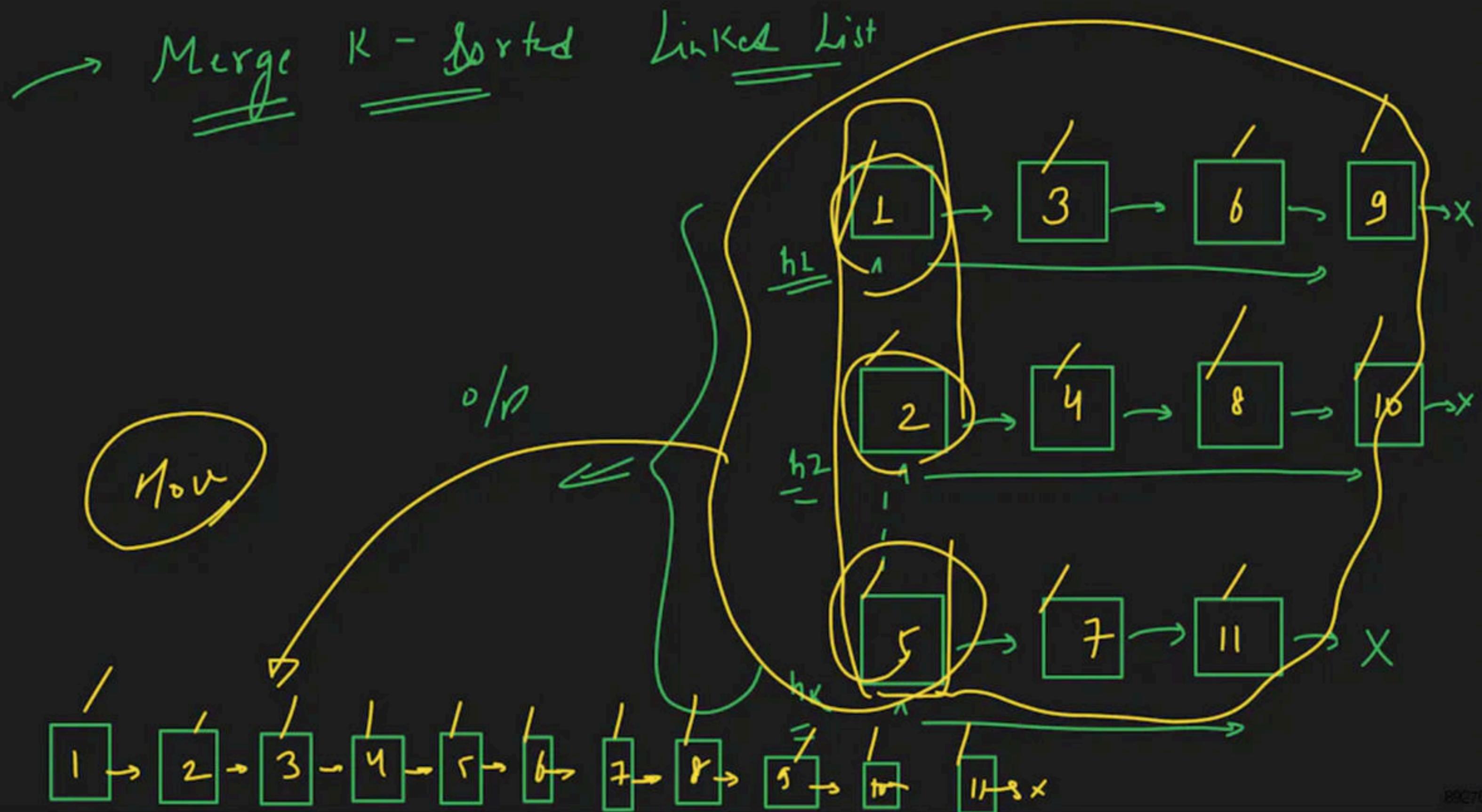
arr_3

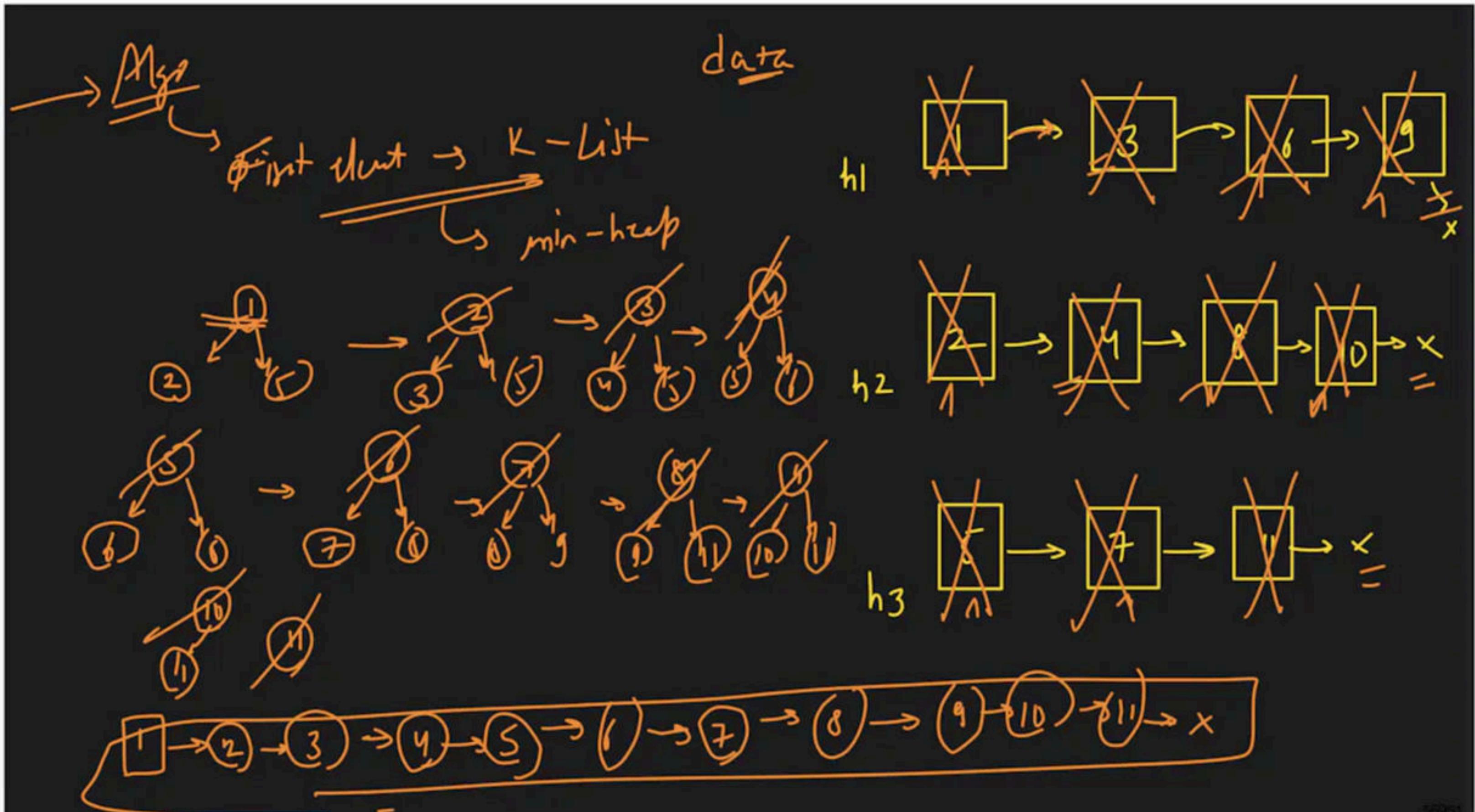


K = 3





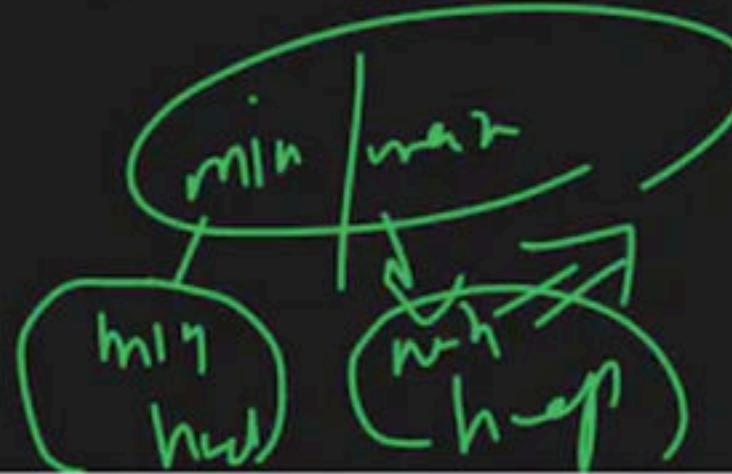




$\Rightarrow \delta_{\text{smallest}}$

min days

find A_2



Range in K-list

$0-5 \rightarrow 5$

$4 \rightarrow 5$

$5-10 \rightarrow 10$

$9-14 \rightarrow 14$

$10-15 \rightarrow 15$

$12-18 \rightarrow 18$

$15-20 \rightarrow 20$

$18 \rightarrow 24$

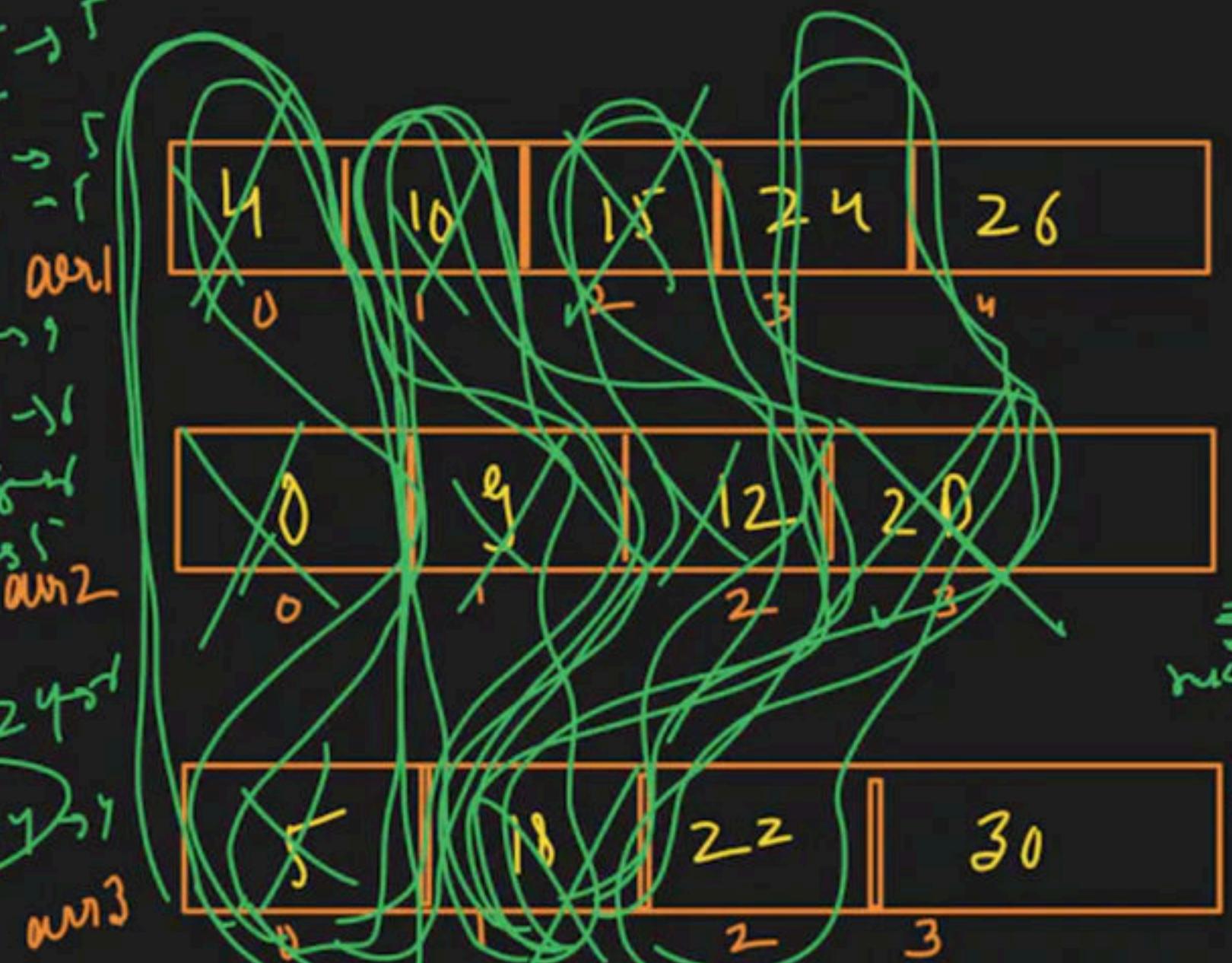
$20 \rightarrow 24$

$20+21 \rightarrow 21$

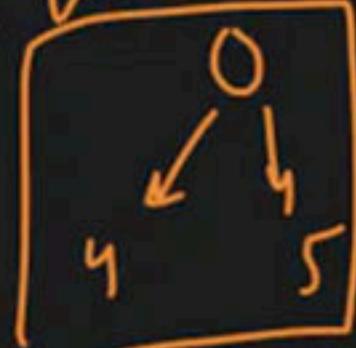
$am3$

$a18$

$min 0 \rightarrow max$



(E) first chut \rightarrow k-list
mix-hup



$$\max = 5$$

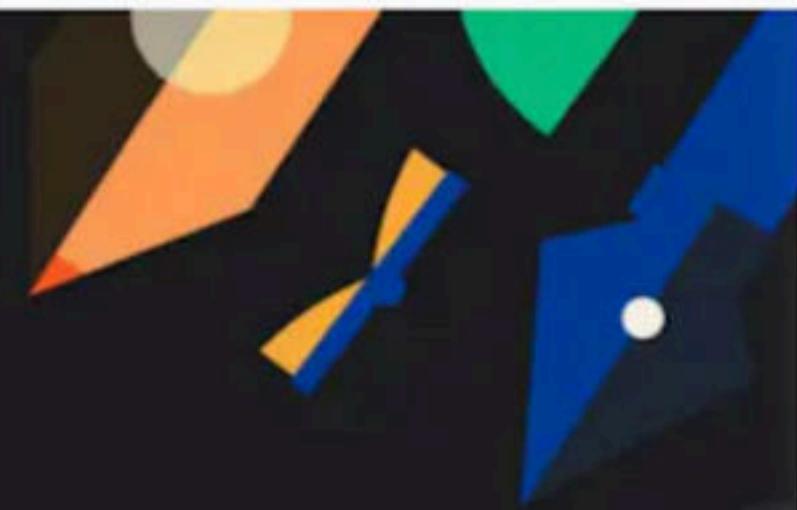
ans - $\min = 0$
ans - $\max i \geq 5$

~~4~~ 5
~~5~~ 5
5 5
5 10
max i = 9
max i ≥ 10
 \Rightarrow comprehension

arr 1	4	10	15	24	26
	0	1	2	3	4

arr 2	0	9	12	20	
	0	1	2	3	

arr 3	5	18	22	30	
	0	1	2	3	



Heap Class-4

Special class

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→ 1 min → focus

$$[4 \quad 3 \quad 6 \quad 7]$$

K=3

7- $\frac{7}{2}$

4

6- $\frac{6}{2}$

4-1

$$[4 \quad 3 \quad 6 \quad 4]$$

K=2

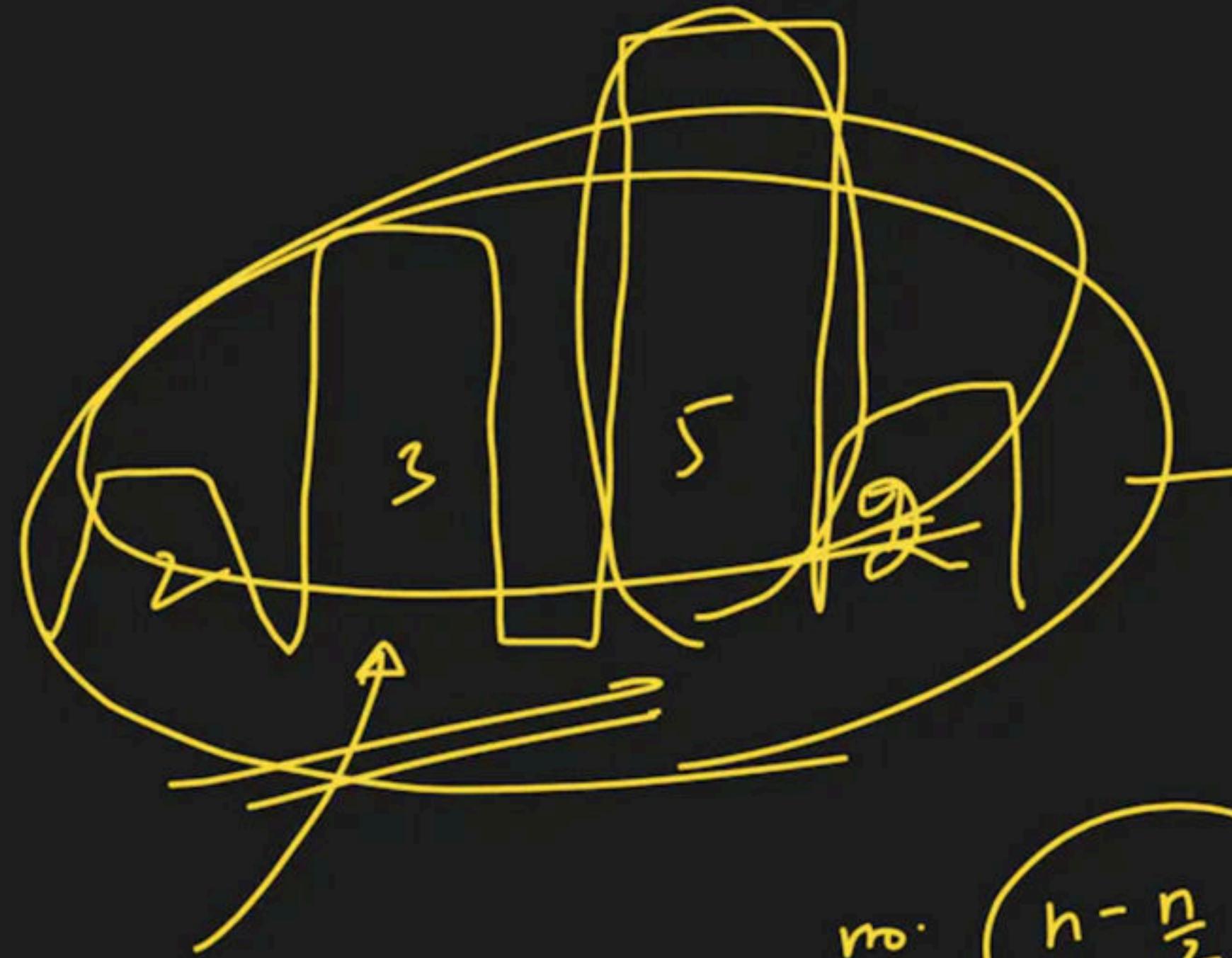
$$[4 \quad 3 \quad 3 \quad 4]$$

K=1

$$(2 \quad 3 \quad 3 \quad 4)$$

= K=0

$$1 + 3 + 3 + 4 = 12$$



$$K = 2$$

mo.

$$n - \frac{n}{2}$$

min no
max heap \rightarrow

$$(5) - \frac{5}{2}$$

fetch \rightarrow 5

$$\text{proc} \rightarrow 5 - \frac{5}{2} 2^3$$

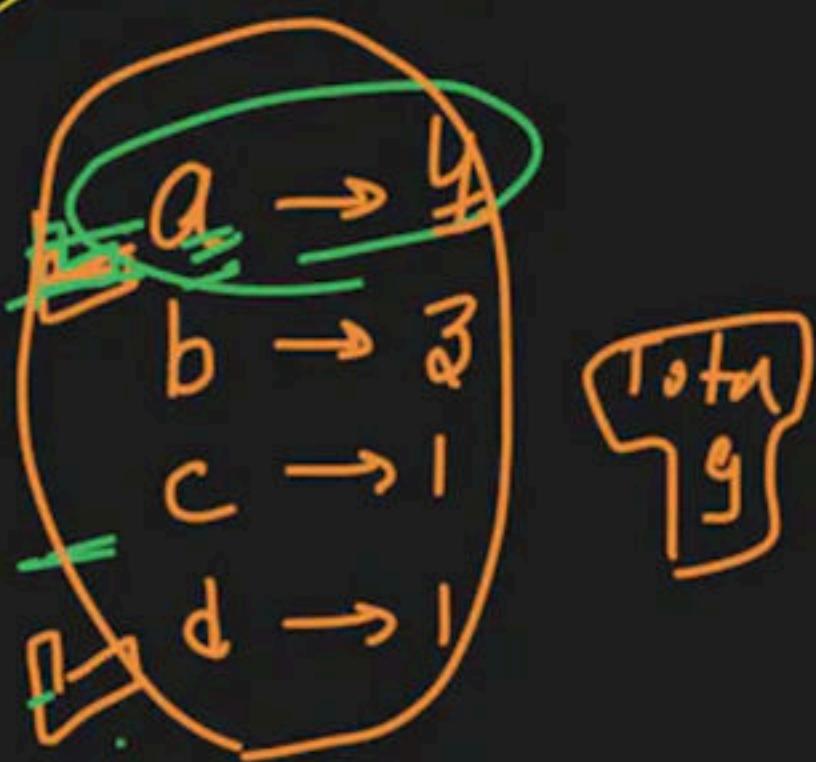
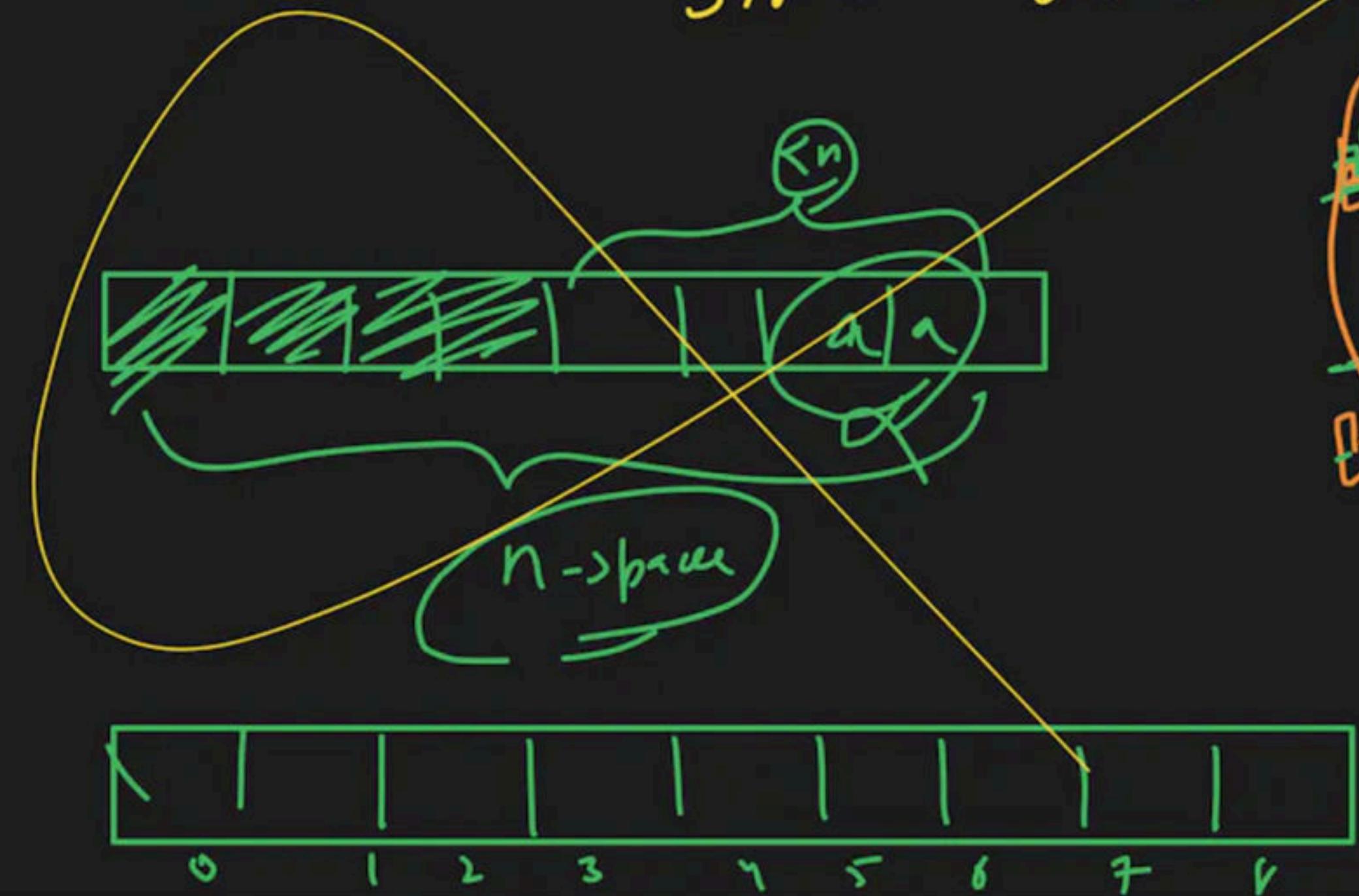
$$\text{push} = 2 \text{ push}$$

$$K! = 0$$

$$3 - \frac{3}{2}$$

→ Reorganise Strings

$\text{str} = \text{"aabbaab cd"}$



$a \rightarrow 4$
 $b \rightarrow 3$
 $c \rightarrow 1$
 $d \rightarrow 1$

5-1r = " sp ssp sss p n h i l a g r a d a r r "

top → 2 elant

bus put → elan → try up cat
punt man hook

s	p	a	s	r	a	d	l	h	i	l	a	r	d
---	---	---	---	---	---	---	---	---	---	---	---	---	---

↑
man - hook

man - hook

man - hook

0



58484

→ Longest

Happy = string :-

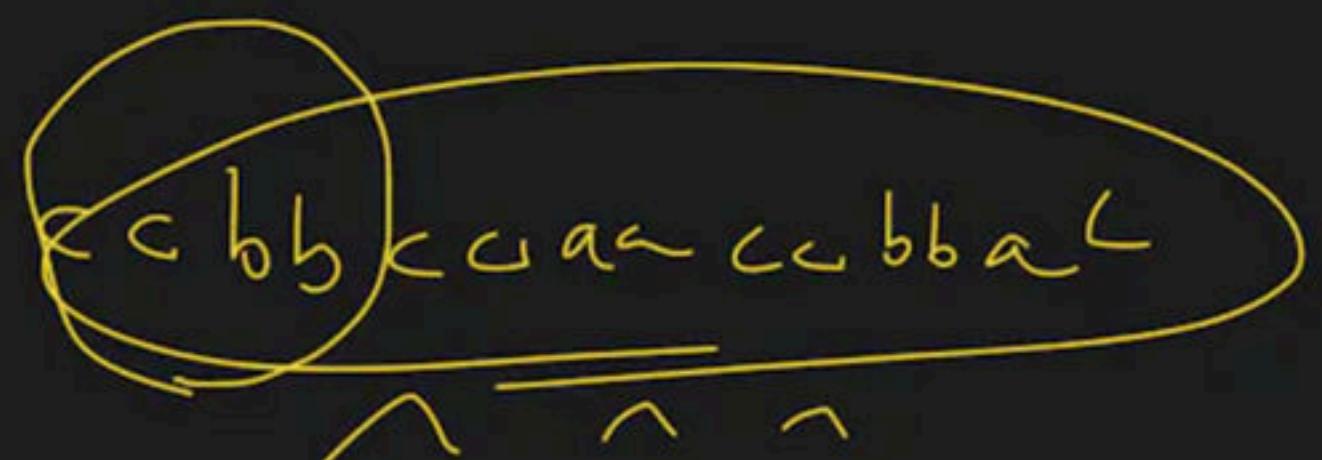
$a \rightarrow a'$ times (almost)
 $b \rightarrow b'$ times
 $c \rightarrow c'$ times

$a \rightarrow 3$
 $b \rightarrow 4$
 $c \rightarrow 7$

$\underline{a} \rightarrow \cancel{*} \cancel{*} \cancel{*} \cancel{*}$
 $\underline{b} \rightarrow \cancel{*} \cancel{*} \cancel{0}$
 $\underline{c} \rightarrow \cancel{*} \cancel{*} \cancel{*}$

\rightarrow 

and
bab
ccc


ccbabacbabac

$\Rightarrow a = 5, b = 4, c = 8$ $Pq < Pa \text{ by } \langle \text{int}, \text{int} \rangle >$



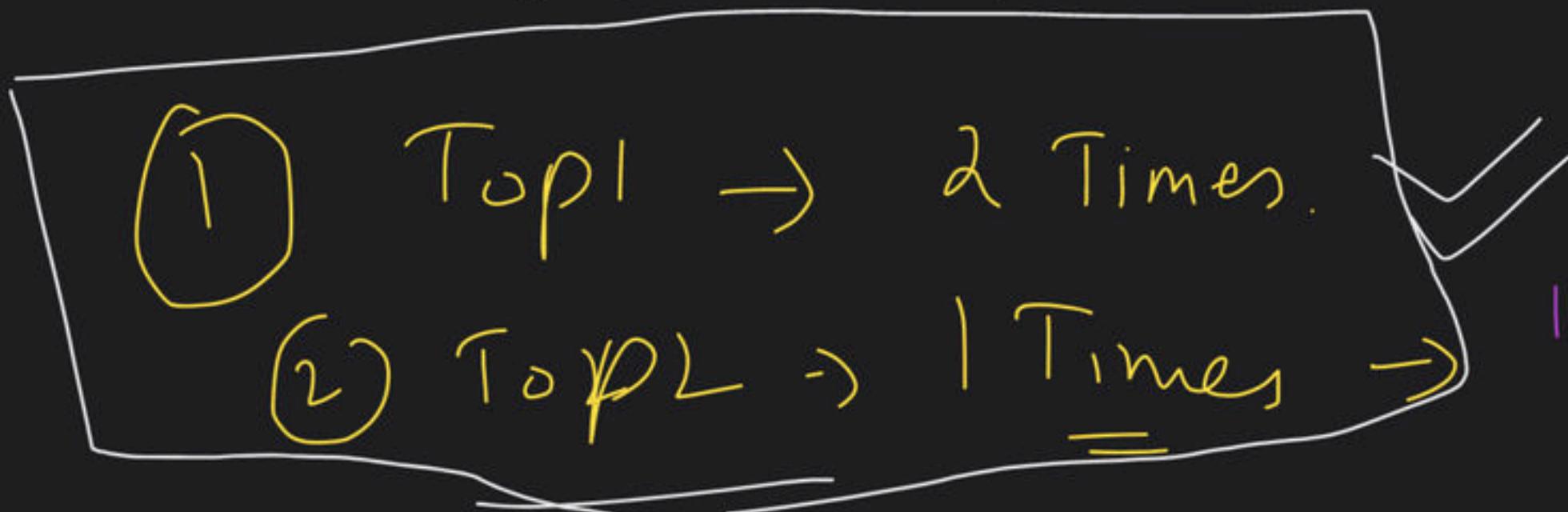
① $Top = \langle a, |$

② $Top2 =$

freq

a, |

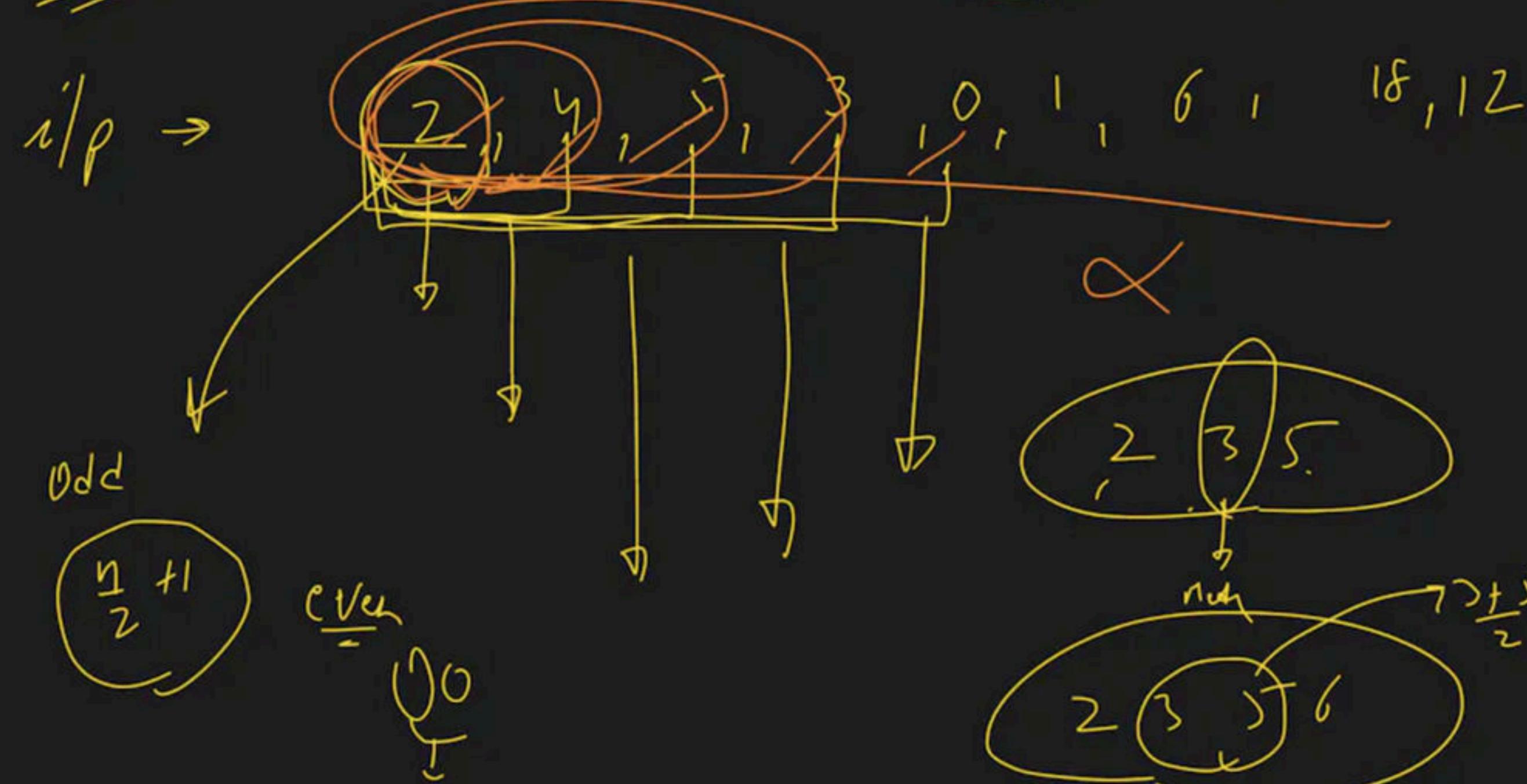
$\frac{c}{0} \frac{c}{1} \frac{a}{2} \frac{a}{3} \frac{c}{4} \frac{c}{5} \frac{b}{6} \frac{b}{7} \frac{c}{8} \frac{c}{9} \frac{a}{10} \frac{a}{11} \frac{b}{12} \frac{b}{13} \frac{c}{14} \frac{c}{15} \frac{a}{16}$



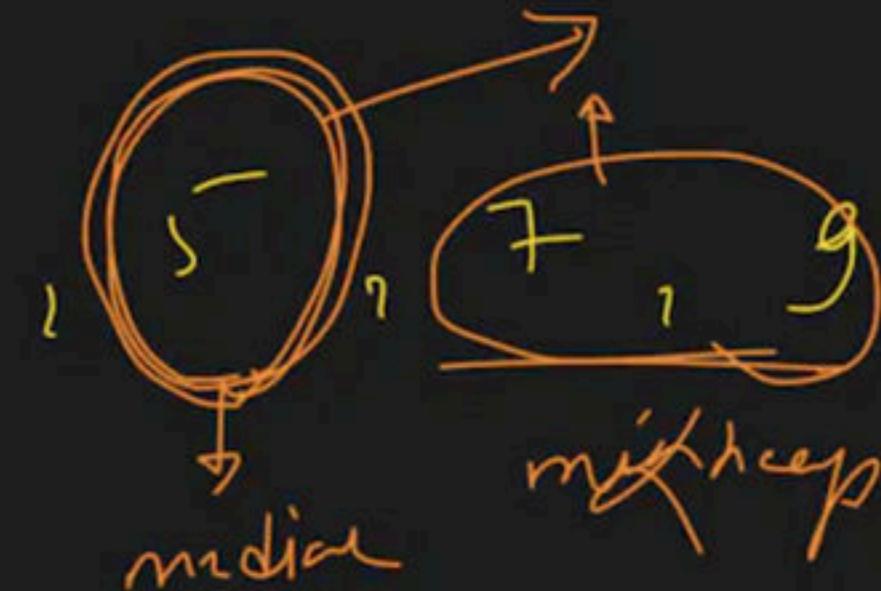
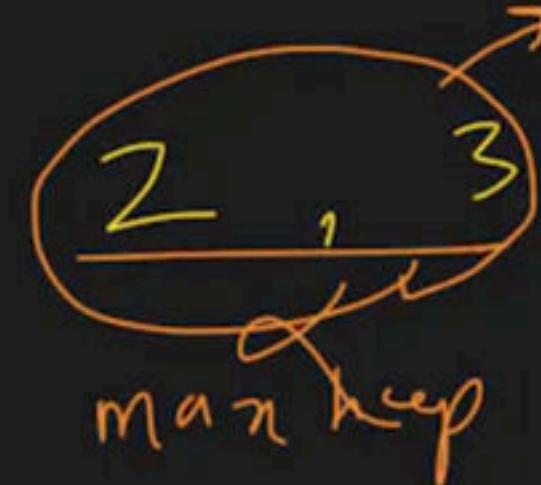
Time Print
Invoke hi
Batch Langs

→ Median in a Stream -

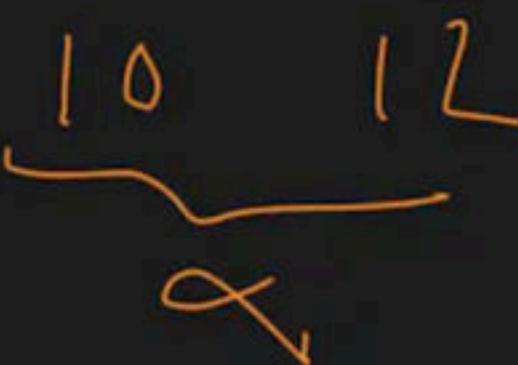
$$n \log n = O$$



Odd →



even →



$$\frac{6+8}{2} = \frac{14}{2} = 7$$

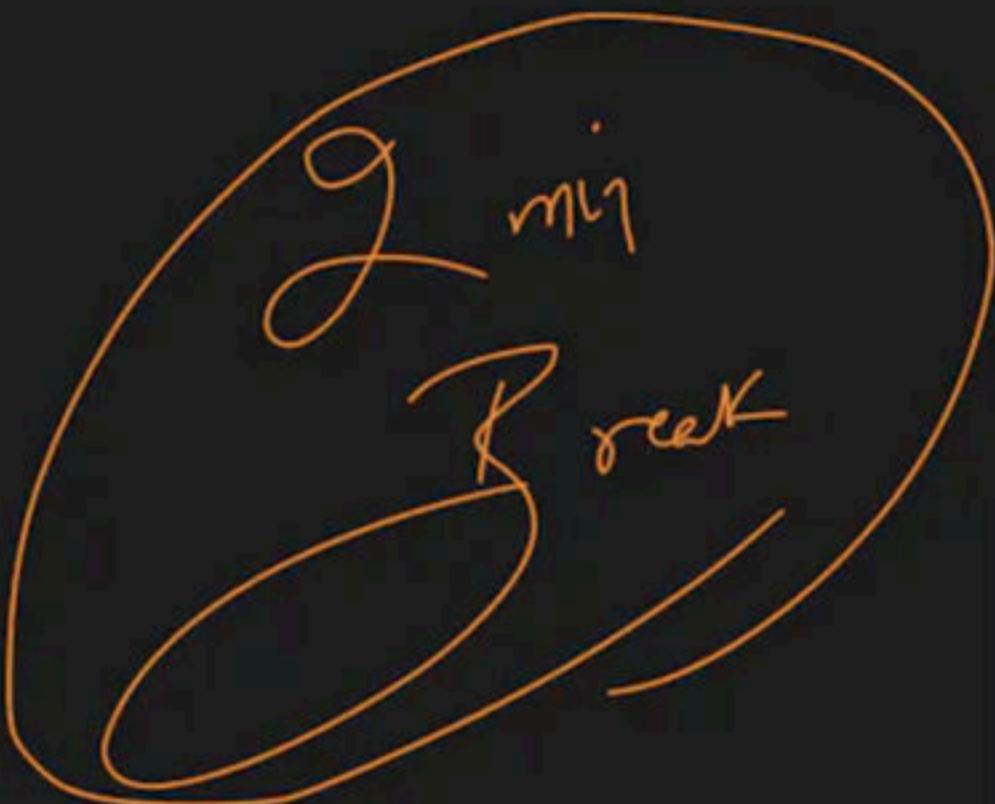
i/ρ

\rightarrow

5, 15, 1, 3, 2, 8

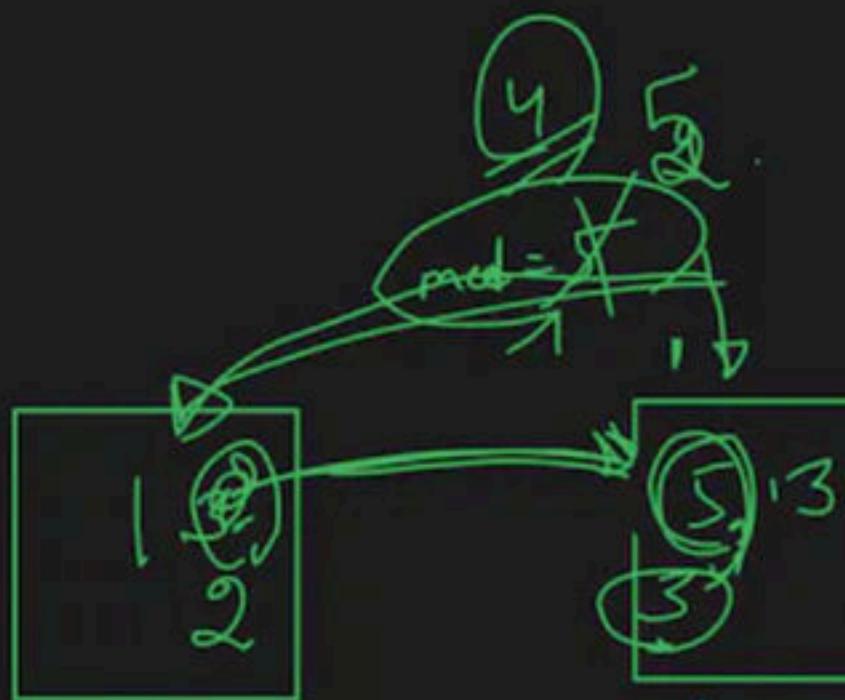
$0/\rho \rightarrow ?$

A/ρ



5, 13, 1, 3, 2, 8

median = 0



$$\min\text{heap} = \frac{\max\text{size} + 1}{2}$$

no < Brdce

↓
push max

avg

size = 5

size = 2

5 1 13 15 13

max size = min size

no > median → maxpush

max size = min size + 1

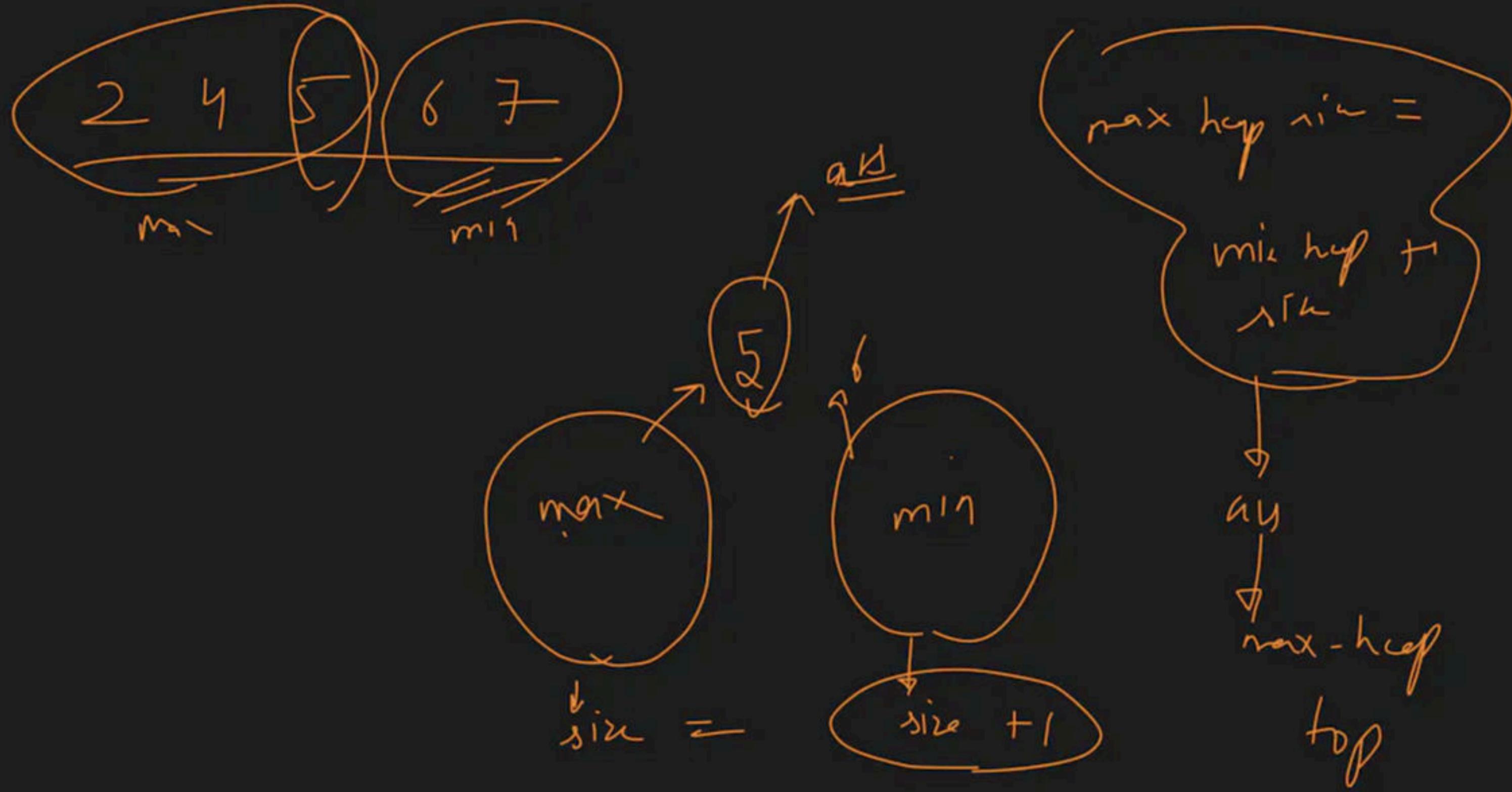
no > median → minpush

median = avg

max size = min size

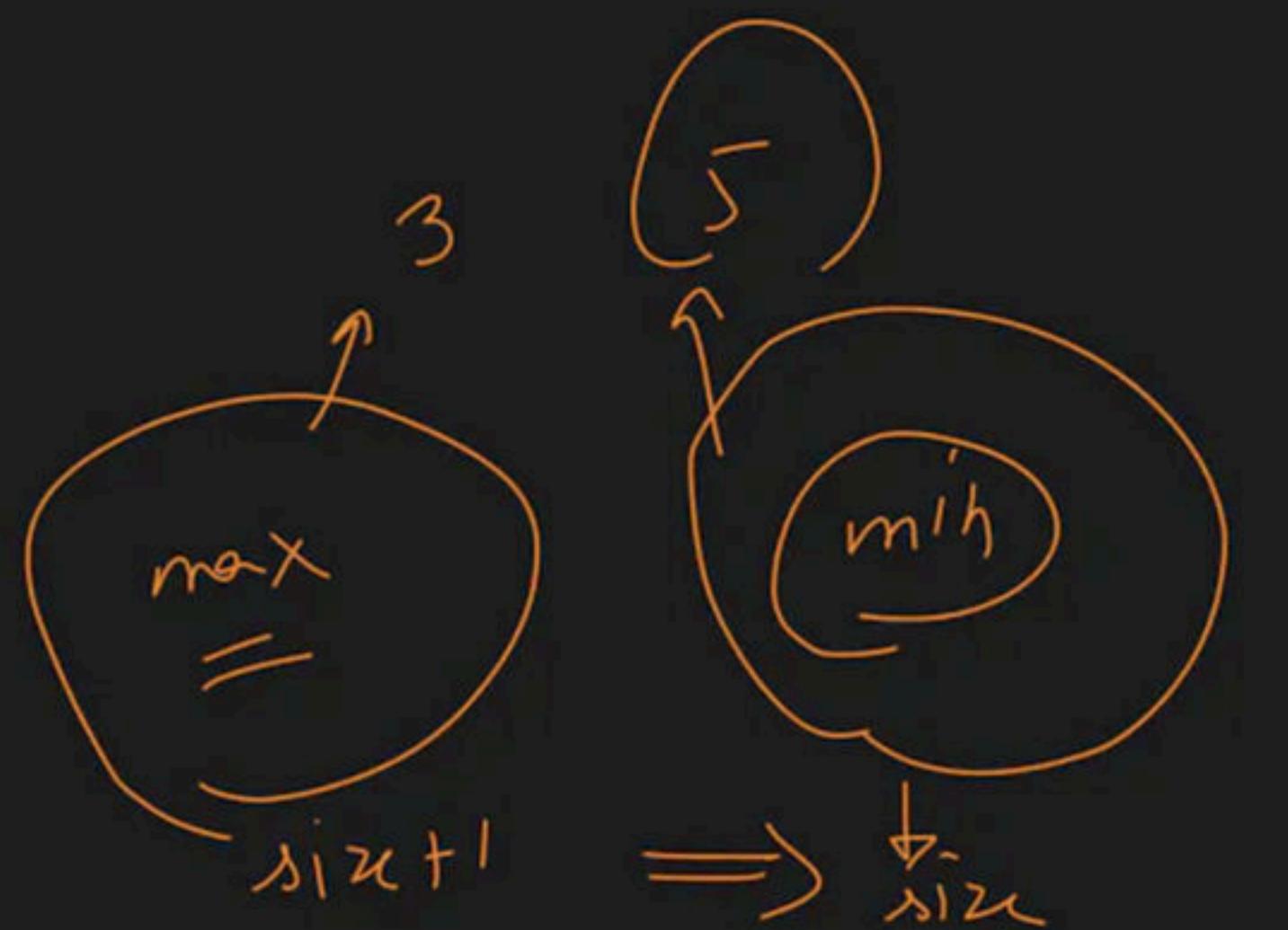
no < median

maxToP → min
no → max





min heap size =
 $\max \text{ heap size} + 1$
 size



ay
 min heap
 top

$\text{avg} \rightarrow \max \text{ top}$
 $\min \overline{\text{top}}$

$$\begin{array}{c} \text{max} \\ \text{hup} \\ \text{size} \\ \gamma \end{array} = \begin{array}{c} \text{min} \\ \text{hup} \\ \text{size} \\ \gamma \end{array}$$

$$\text{diff} = 0$$

$\text{aus} \rightarrow \max \times \overline{\text{top}}$

$$\begin{array}{c} \text{max} \\ \text{hup} \\ \text{size} \\ \gamma \end{array} = \begin{array}{c} \text{min} \\ \text{hup} \\ \text{size} \\ \gamma \end{array} + 1$$

$$= \text{size}$$

$$= 3$$

$$= p$$

$$\text{diff} = 1$$

$\text{als} \rightarrow \min \overline{\text{top}}$

$$\begin{array}{c} \min \text{ hup} = \max \\ \text{size} \\ \gamma \end{array} + 1$$

$$\begin{array}{c} \text{diff} = 1 \\ \gamma \end{array}$$

Obs: -

$$\max \text{ size} = \min \text{ size}$$

$$\checkmark \text{median} \rightarrow \text{avg}(\text{maxTop}, \text{minTop})$$

$$\max \text{ size} = \min \text{ size} + 1$$

$$\checkmark \text{median} \rightarrow (\text{return maxTop})$$

$$\min \text{ size} = \max \text{ size} + 1$$

$$= \text{median} \rightarrow (\text{minTop})$$

insertion

$$\begin{array}{l} \max \\ \text{size} \end{array} = \begin{array}{l} \min \\ \text{size} \end{array}$$

$\text{no} > \text{median}$

push $\min \text{ heap}(\text{no})$

$\text{no} < \text{median}$ push $(\max \text{ heap}(\text{no}))$

$$\begin{array}{l} \max \\ \text{size} \end{array} = \begin{array}{l} \min \text{ size} + 1 \end{array}$$

$\text{no} < \text{median}$

$\text{maxTop} \rightarrow \min$
 $\text{no} \rightarrow \max$

$\text{no} > \text{median}$

push $(\min \text{ top})$

$$\min \text{ size} = \max \text{ size} + 1$$

$\text{no} > \text{median}$

max heap

$\text{no} < \text{median}$

$\rightarrow \min \text{ top} \rightarrow \max$
 $\rightarrow \text{no} \rightarrow \min$

Insertion

min heap size

\leq

max heap size + 1

$n_0 > \text{child size}$

min bp \rightarrow max

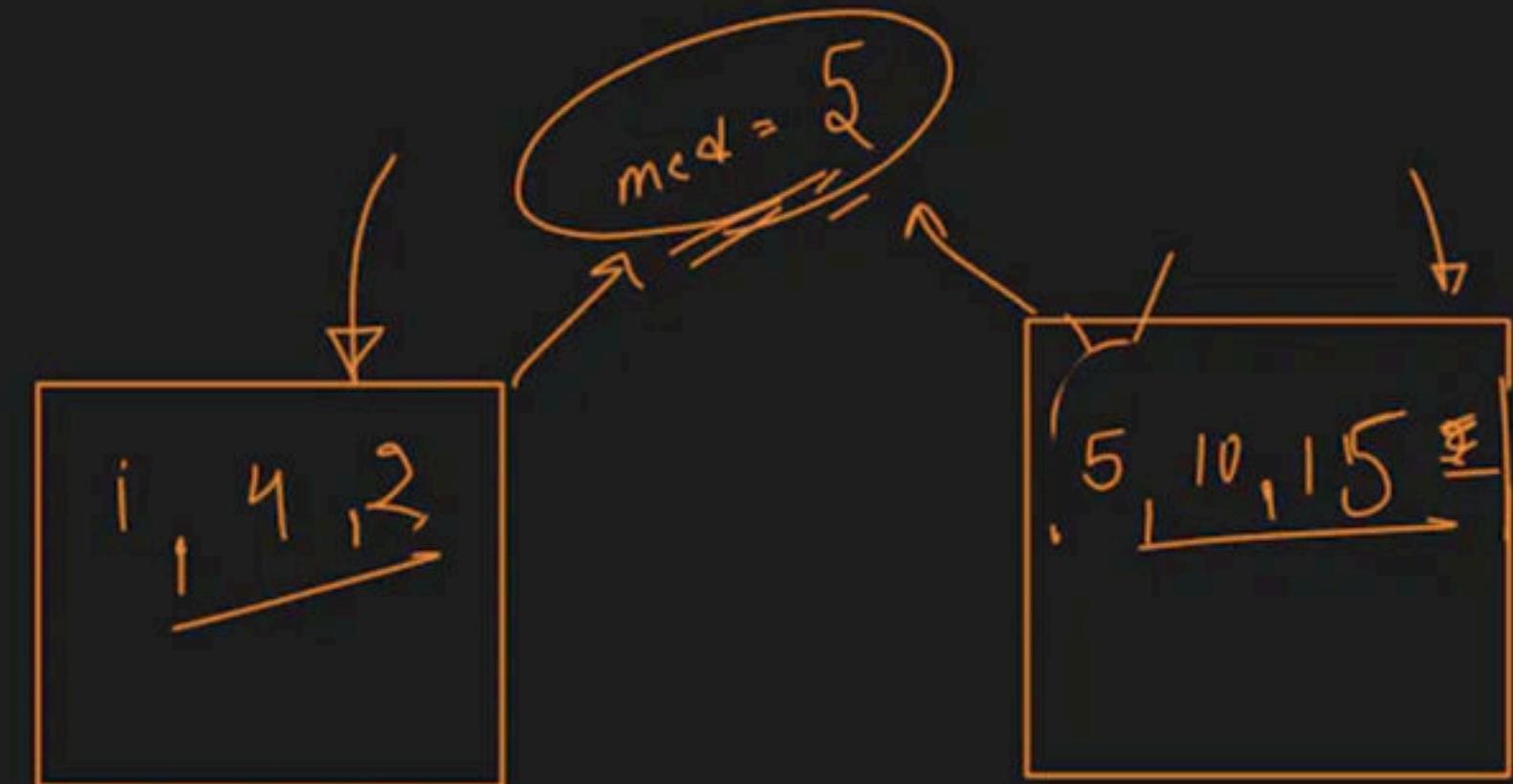
elmt \rightarrow min

$n_0 < \text{child size}$

maxi-pnt

$n_0 = 2^r$

$n_0 = 2^r$



⇒

Sort ✓

2 3 4

2 3 4 5

Avg.

2 4 5 3 0 1 6 18 12

$$n(\log n + n)$$

n^2

2 ✓

2 4 5 3 →
↓

2 4 → $\frac{2+4}{2}$

2 4 5 → 4

2 3 4 5

2	4	5
0	1	2

⇒

2 1 3 4 5
0 1 2 3

\Rightarrow

2 4 5 3

3.5

find median
=

\Rightarrow

2

3

4

5

2

3

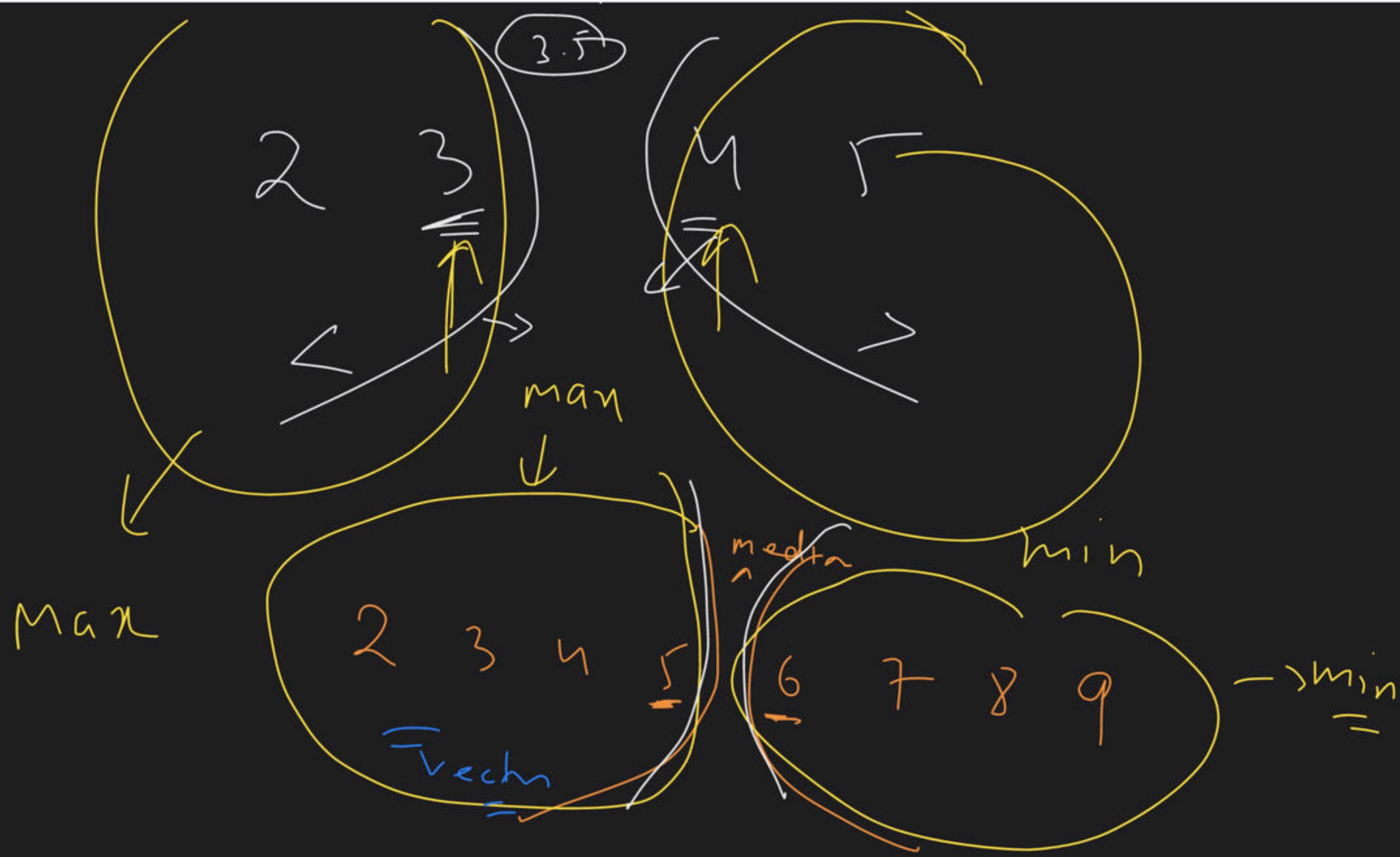
4

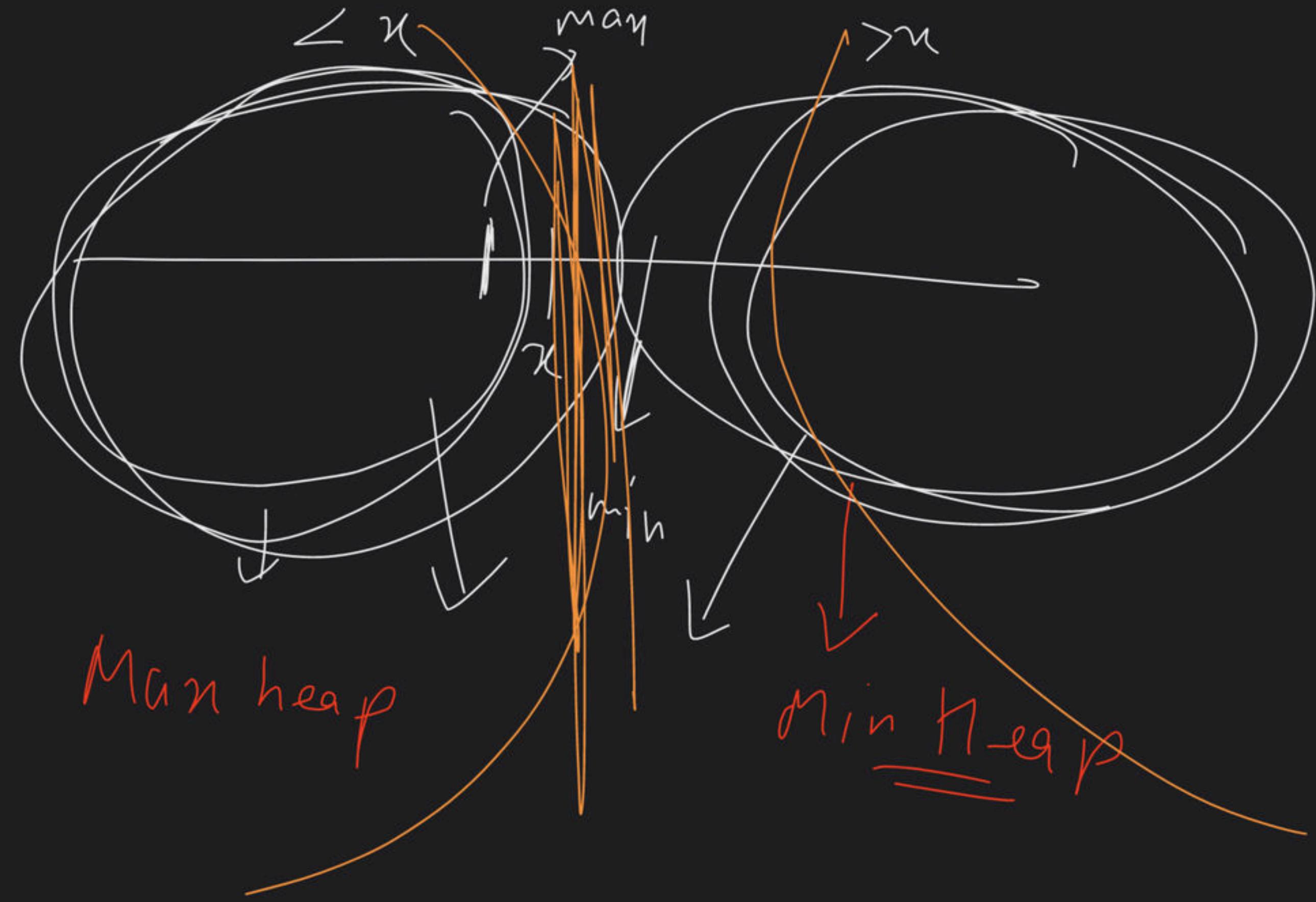
5 6



$< M$

$M >$







\Rightarrow



Aim \Rightarrow Count (max heap)

But \Rightarrow Max heap will have more elements \equiv Count (min heap)

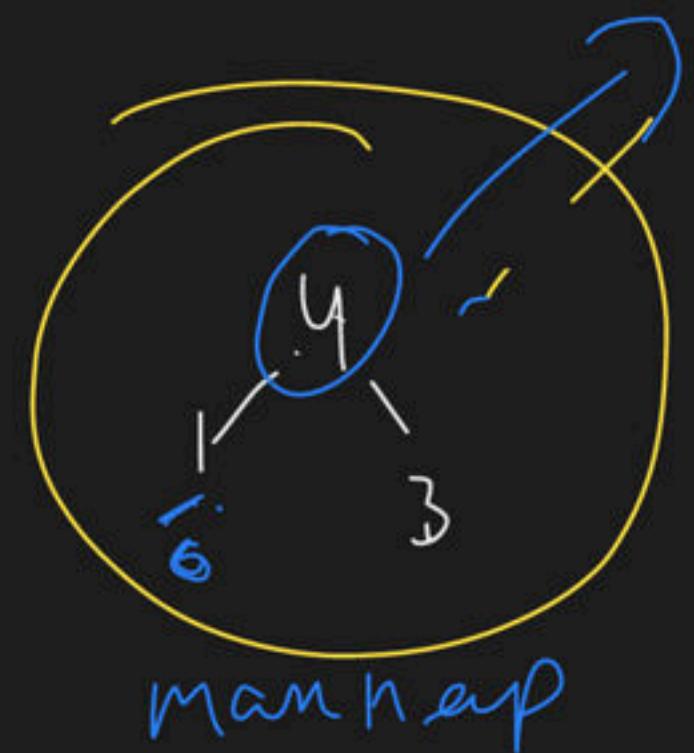
$\Rightarrow 1 \ 3 \ \leq \ 4 \ 7 \ 8 \ 0$

$\Rightarrow N_ManH \equiv N_Min$



$\Rightarrow \cancel{8} \cancel{4}$ insert

$\cancel{7} \ 8$



man heap

if (num < man heap.Top())

push h Man

else

min heap

else ret Man heap.Top()



min heap



