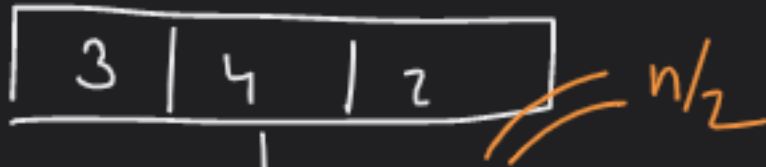
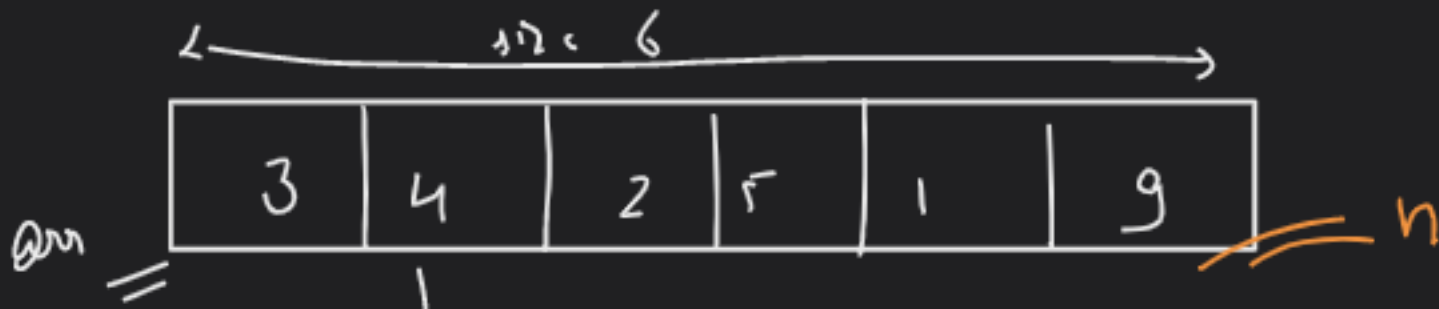




Divide and Conquer - LIVE

Special class

→ Q-1



.....

①

inp \rightarrow



⋮



3 | 4 | 1 | 5 | 9 | 2

3 | 4 | 1

3 | 4

3

using
recursion

2 min

think

o/p)

3 4 1 5 9 2

3 4 1

3 4

3

```
solve ( )  
// B.C  
for loop -> print  
// R.C  
}
```

→

arr, size

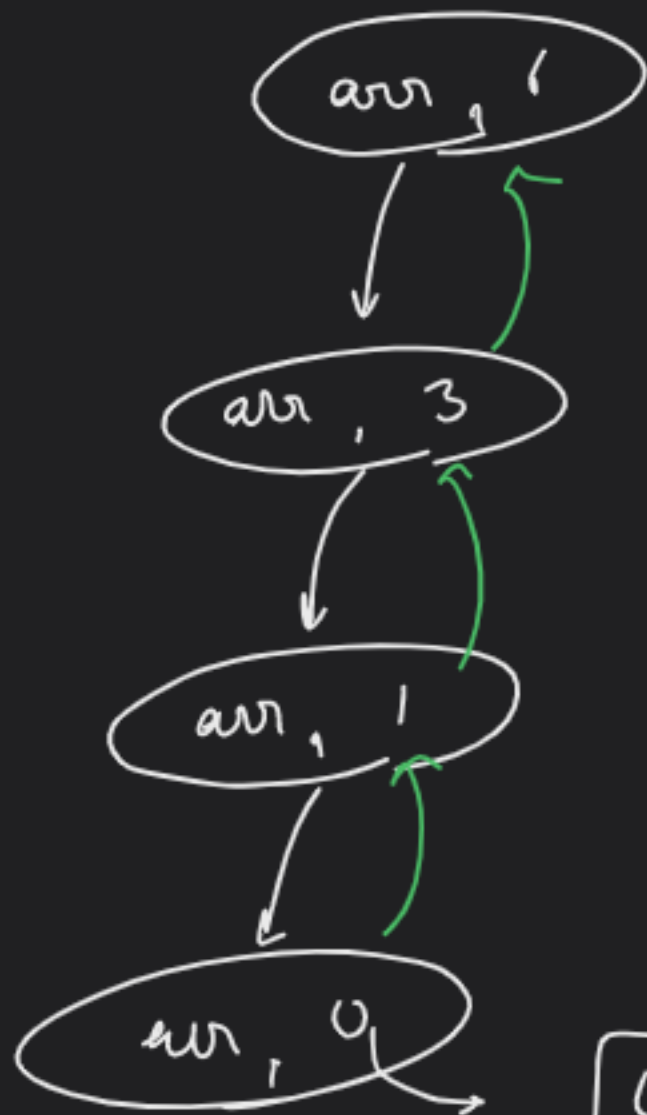
B.C

```
if (size < 1)  
    return;
```

↓
why?

$\boxed{2 \mid 4 \mid 1 \mid 5 \mid 2 \mid 1}$

size = 6

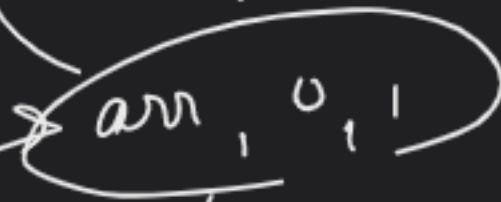
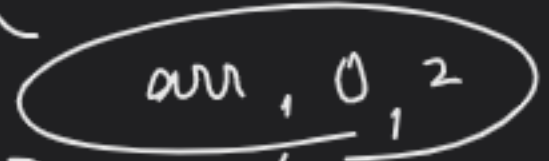
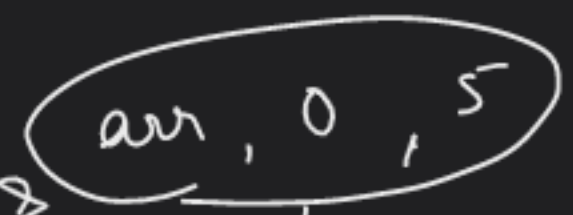
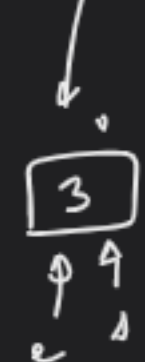
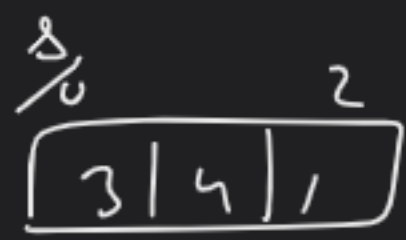
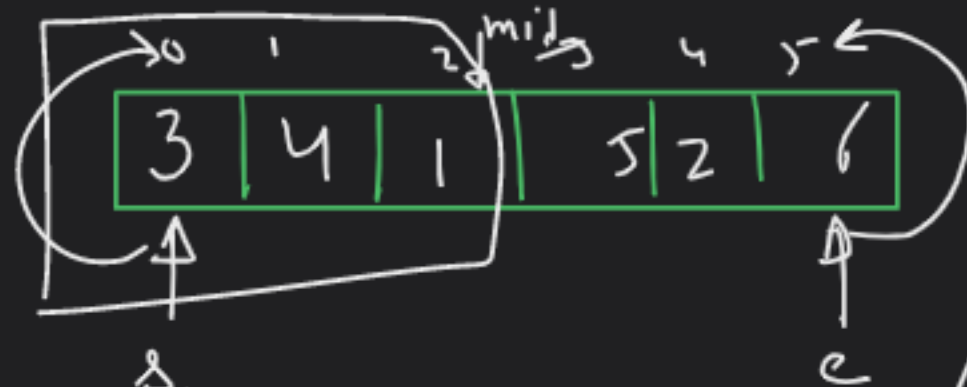


$$6/2 \rightarrow 3$$

$$3/2 \rightarrow 1$$

$$1/2 \rightarrow 0$$

$\boxed{0 < 1} \rightarrow \text{Base case} \rightarrow \text{return}$



$$\begin{aligned} \text{mid} &= \frac{\text{start} + \text{end}}{2} \\ &= \frac{0 + 5}{2} \\ &= \frac{5}{2} = 2 \end{aligned}$$

$$\begin{aligned} \text{mid} &= \frac{\text{start} + \text{end}}{2} \\ &= \frac{0 + 2}{2} \\ &= 1 \end{aligned}$$

$$\text{mid} = \frac{0 + 1}{2} = 0$$

$$\text{mid} = \frac{s + e}{2}$$

$$\text{mid} = s + \frac{e - s}{2}$$

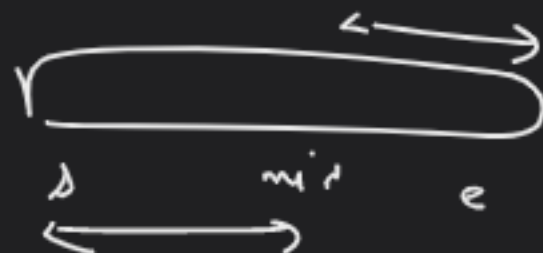
$$\ggg 2$$

$$= s + \frac{e - s}{2}$$

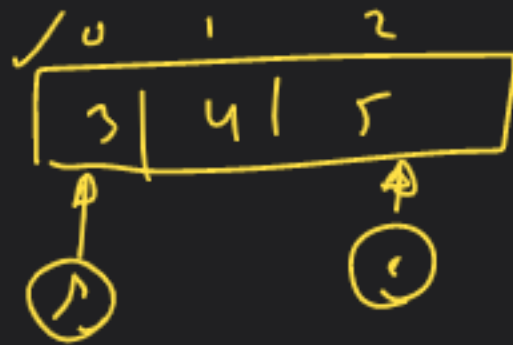
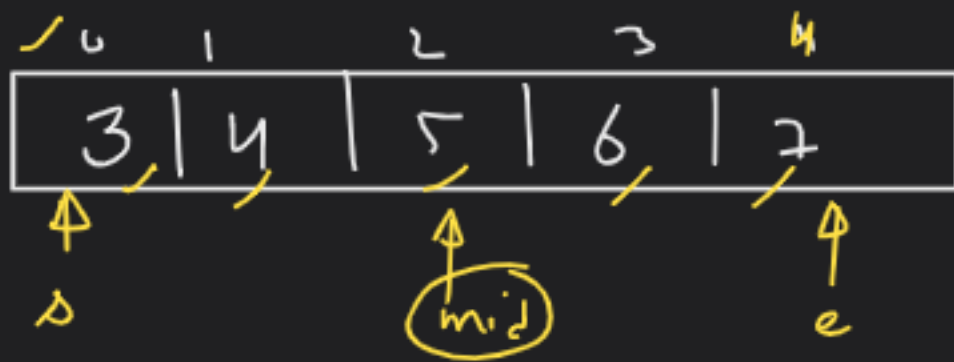
$$= \frac{s}{2} + \frac{e}{2} = \frac{s + e}{2}$$

Why this is not good

$\text{soln}(\text{aru}, s, \text{mit})$



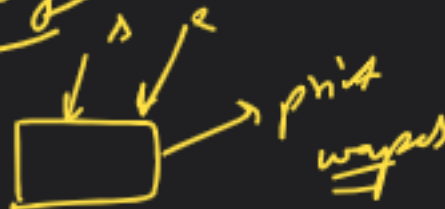
$\text{soln}(\text{ar}, \text{midt}, e)$



$s > e$

$s == e$

Invalid range



arr, 0, 4

print 1 → 2

$$mid = \left(\frac{s+e}{2} \right) = \frac{0+4}{2} = 2$$

arr, 0, mid

print s → mid

$$mid = \frac{s+e}{2} = \frac{0+2}{2} = 1$$

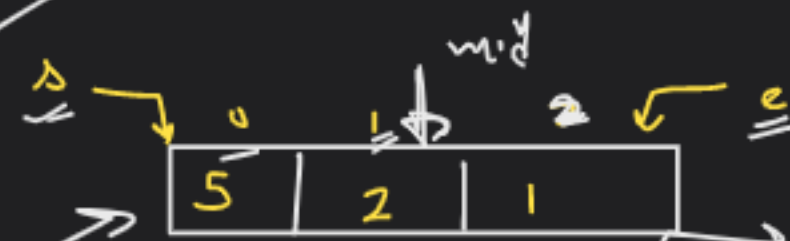
arr, s, mid



$$mid = \left(\frac{s + e}{2} \right) = \frac{0 + 5}{2} = \frac{5}{2} = 2$$

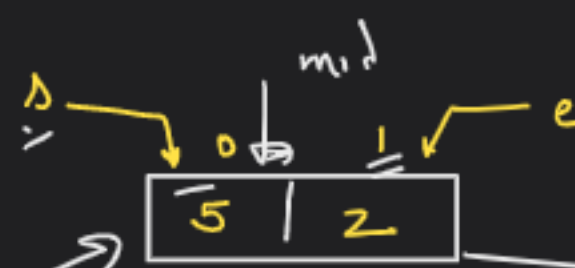
$$mid = \left(\frac{s + e}{2} \right)$$

$$0, 0$$

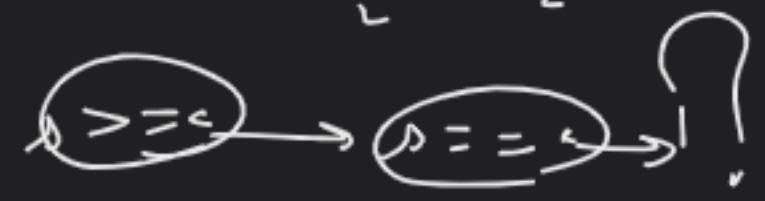


$$mid = \frac{s + e}{2} = \frac{0 + 2}{2} = 1$$

$$s > e$$



$$mid = \frac{s + e}{2} = \frac{0 + 1}{2} = 0$$



$s == e \rightarrow$ single element

$$s > e$$

NO \rightarrow print \rightarrow return

5 2 1 9 7 0

5 2 1

5 2

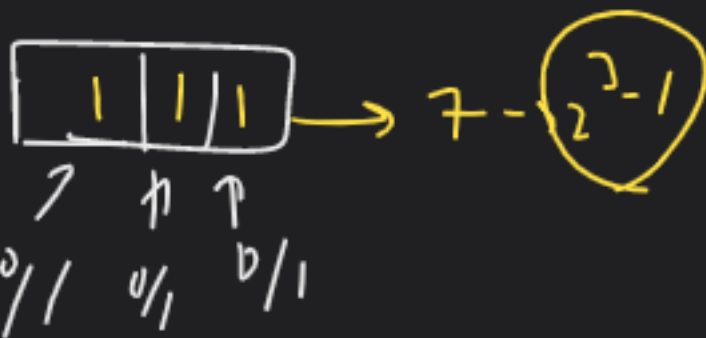
5

o/p

$$\Delta + (2^{\frac{L}{2}} - 1)$$

$$\Delta + \frac{c}{2}$$

$$\left(\frac{\Delta + c}{L} \right) - \left(\frac{\Delta + c}{2} \right) =$$



$$\left(\frac{\Delta + c}{L} \right)$$

$$\text{int} \rightarrow \underline{\underline{32 \text{ bit}}}$$

$$\begin{aligned} \Delta &= 2^{32} - 1 \\ c &= 2^{31} - 1 \end{aligned}$$

$$2^{32} - 1$$

$$\Delta + c$$



~~2~~

integer

[1, 100]

$$s = 100$$

$$e = 100$$

$$s = 1$$

$$e = 100$$

$$s + e \rightarrow 100 + 100 \rightarrow 200$$

Integer

Overflow

$$s - e = 1 - 100 = -99$$

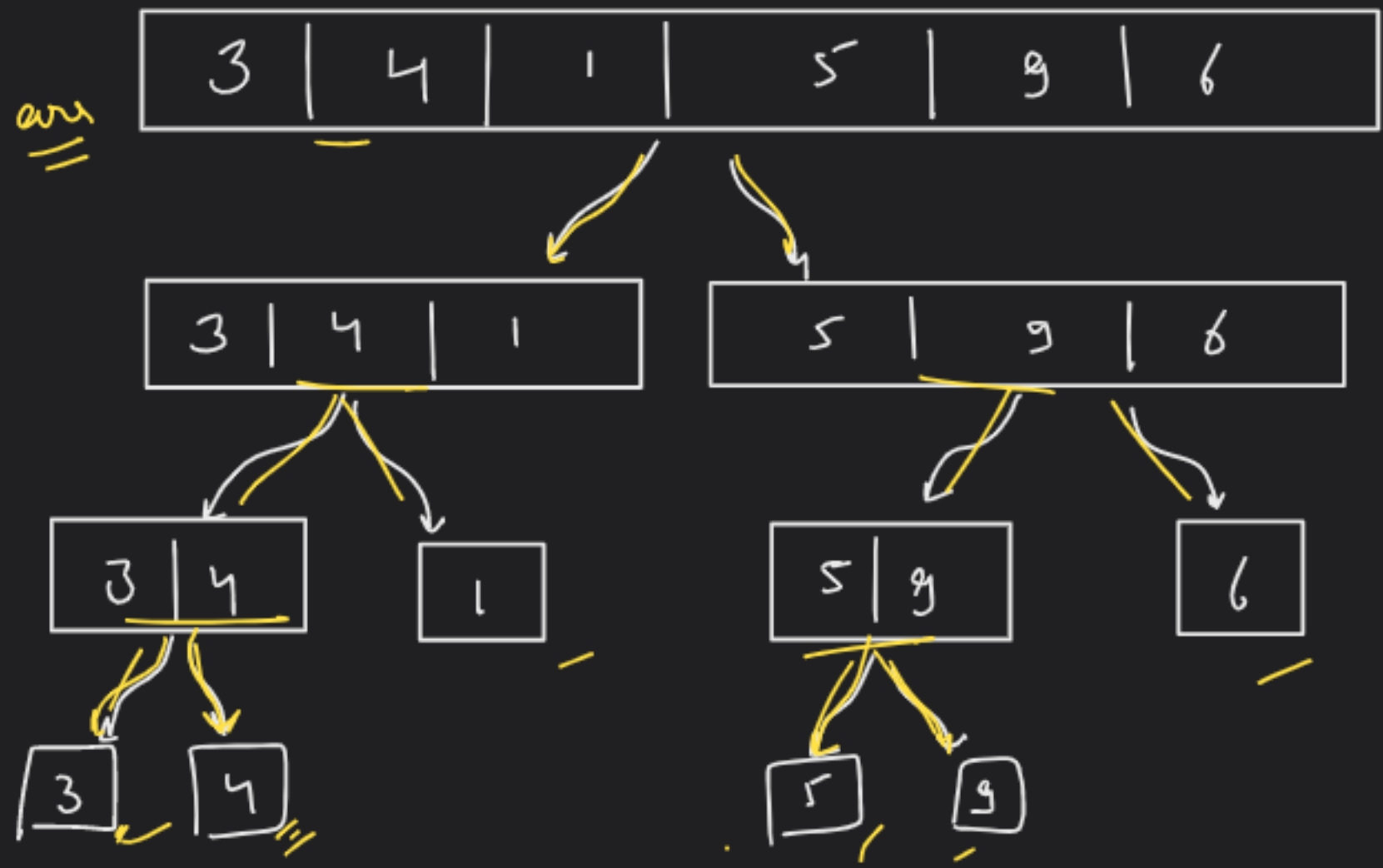
Integer

Underflow

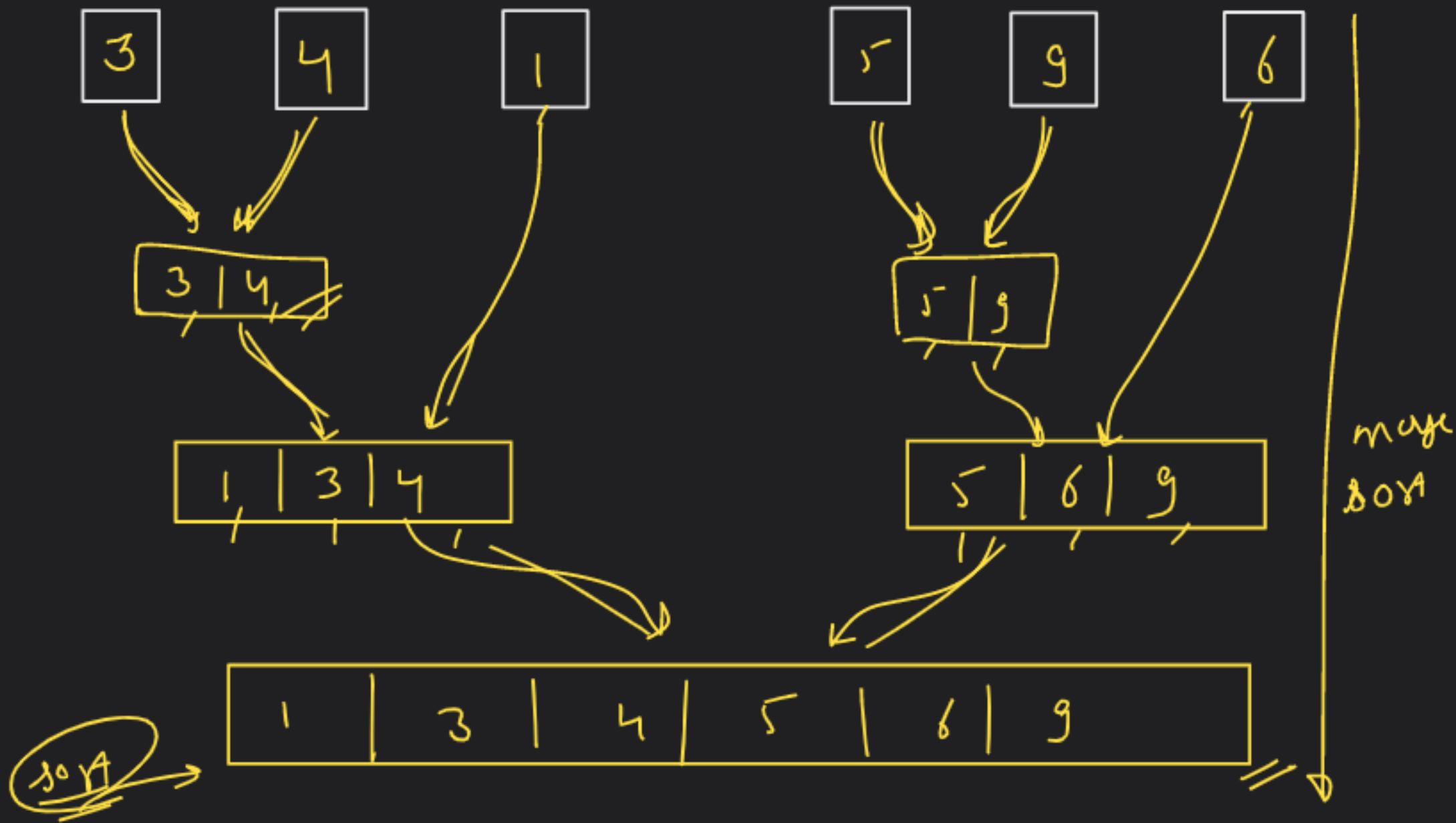
Q-1

ans

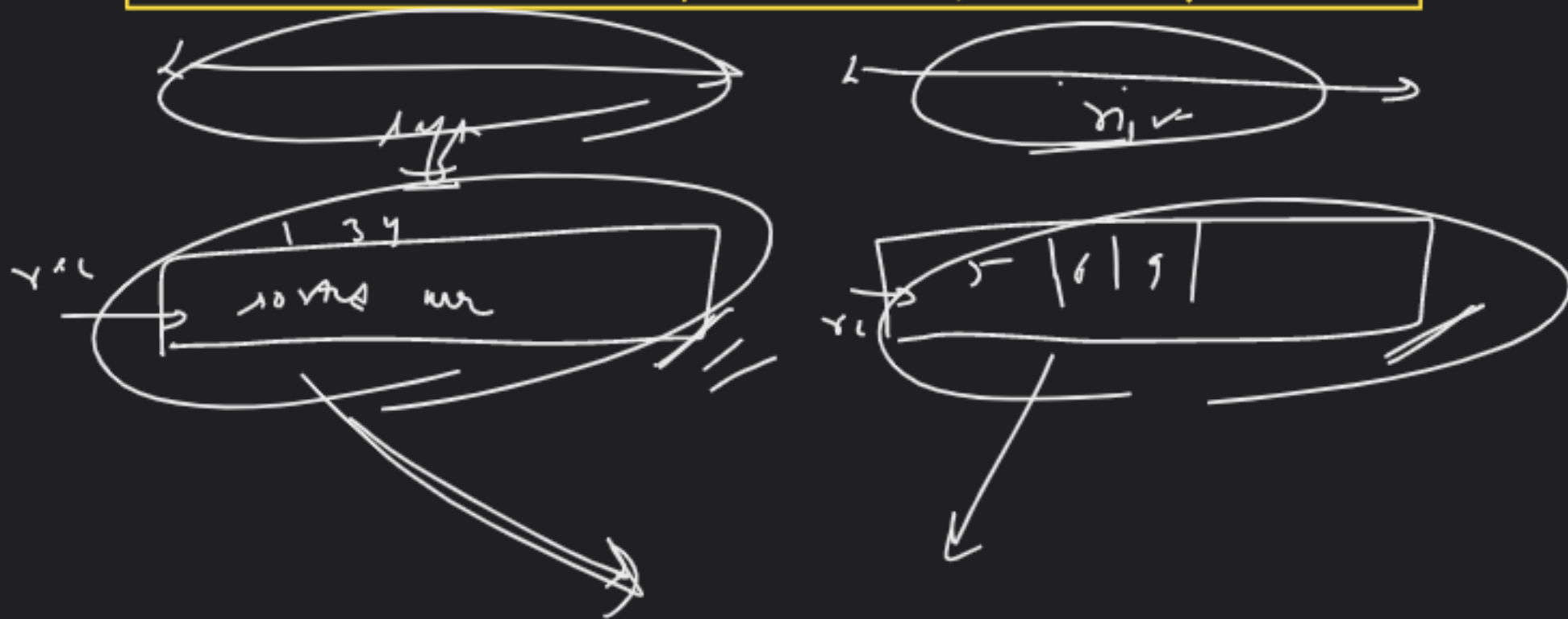
What



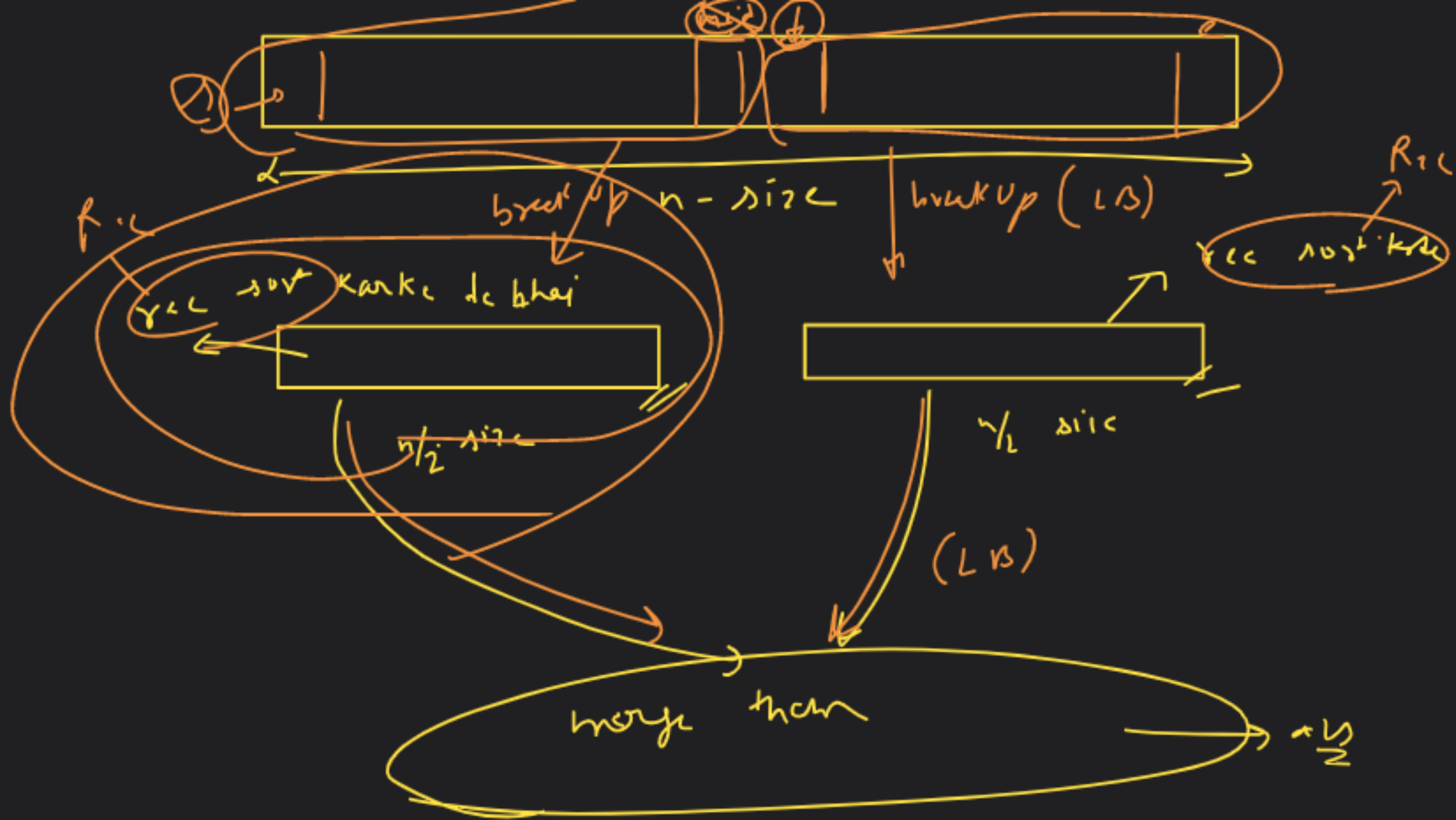
breaking phase



0	1	2	3	4	5
3	4	1	5	9	6



Merge 2 sorted arrays





2 sorted arrays

→ merge them

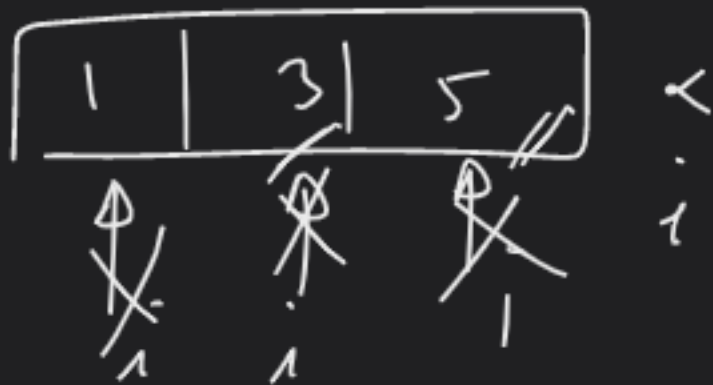
1	3	4
---	---	---

~~1~~
~~1~~
~~1~~
~~1~~

5	6	9
---	---	---

~~5~~
~~5~~
~~5~~
~~5~~

1 3 4 5 6 9



1 2 3 4 5 6

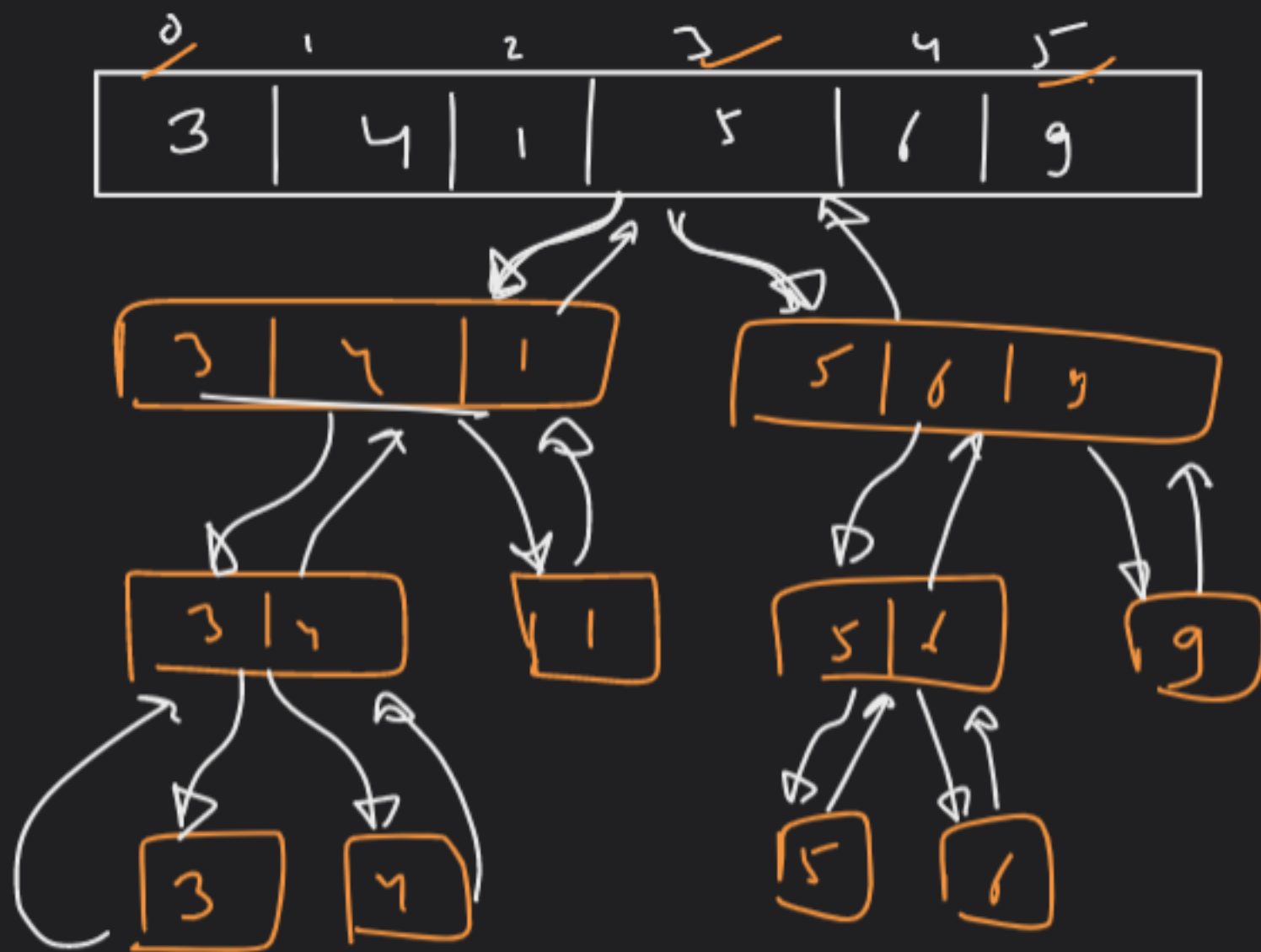
merge(arr, s, mid, e)

$I^{1L} \rightarrow s \rightarrow \underline{\underline{mid}}$

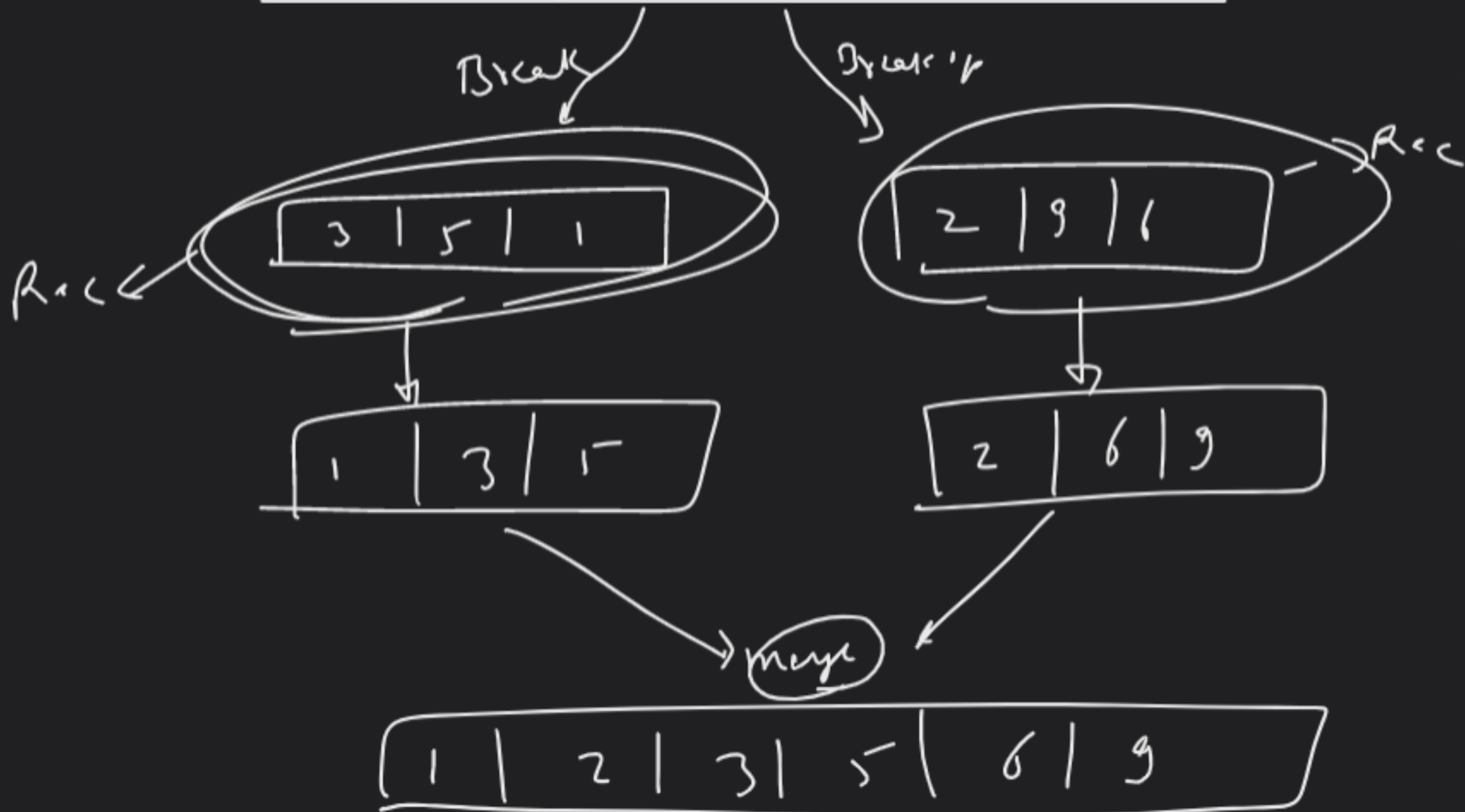
$I^{1R} \rightarrow \underline{\underline{mid+1 \rightarrow e}}$

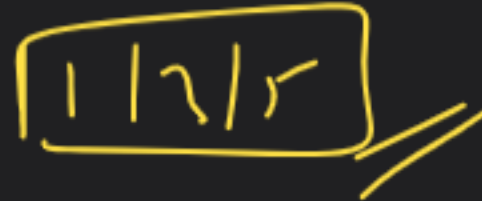
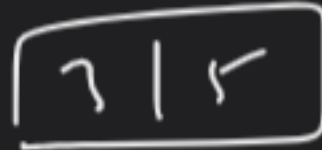
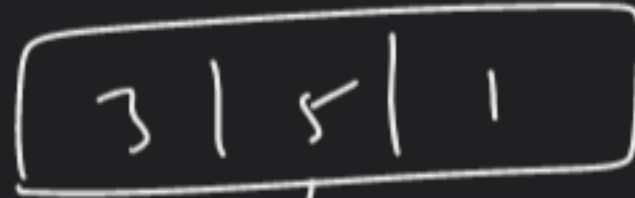






mid - 1 + 1



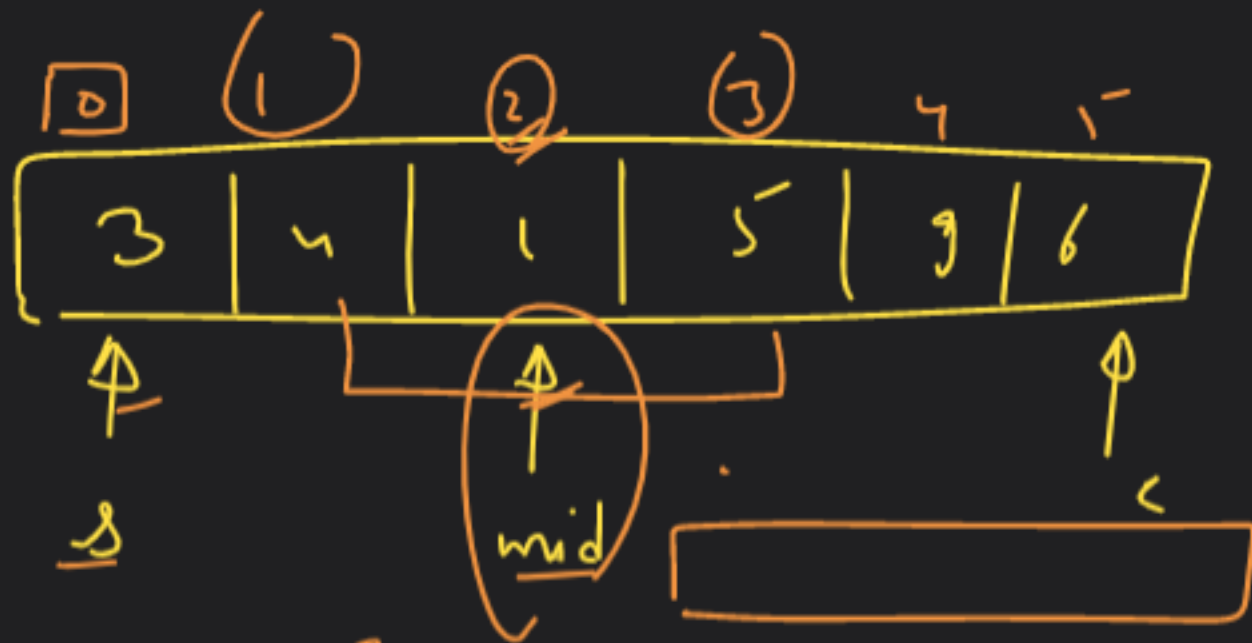


H/W

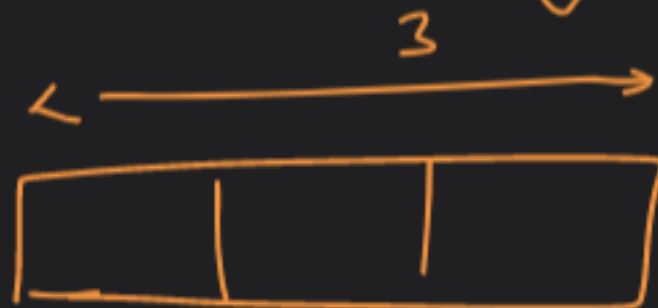
Count Invasion

same
code

Inc
+ LOC



$$\frac{3 - 1}{1} = 2$$



$$\text{len} = \text{mid} - \text{s} + 1$$

$$= 2 - 0 + 1$$

$$= 3$$

$$5 - 3 = 2 + 1$$

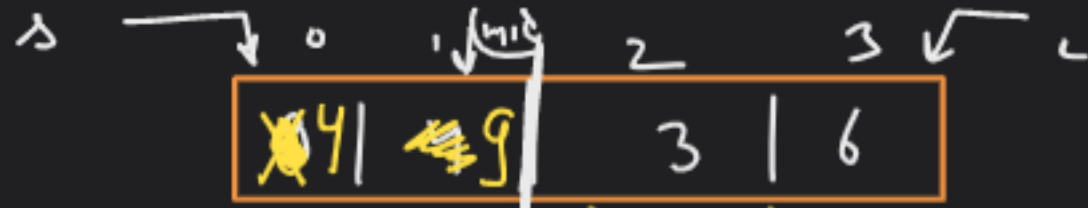
$$e = (\text{mid} + 1) + 1$$

$$e = \text{mid} + 1$$

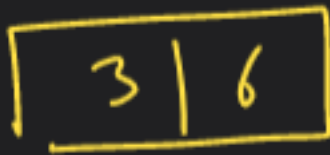


$$\text{len1} = \text{mid} - s + 1$$

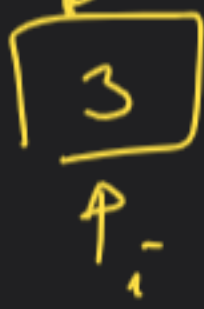
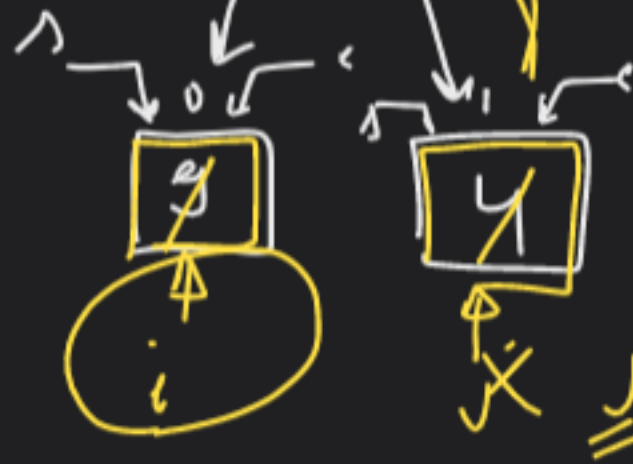
$$\text{len2} = e - \text{mid}$$

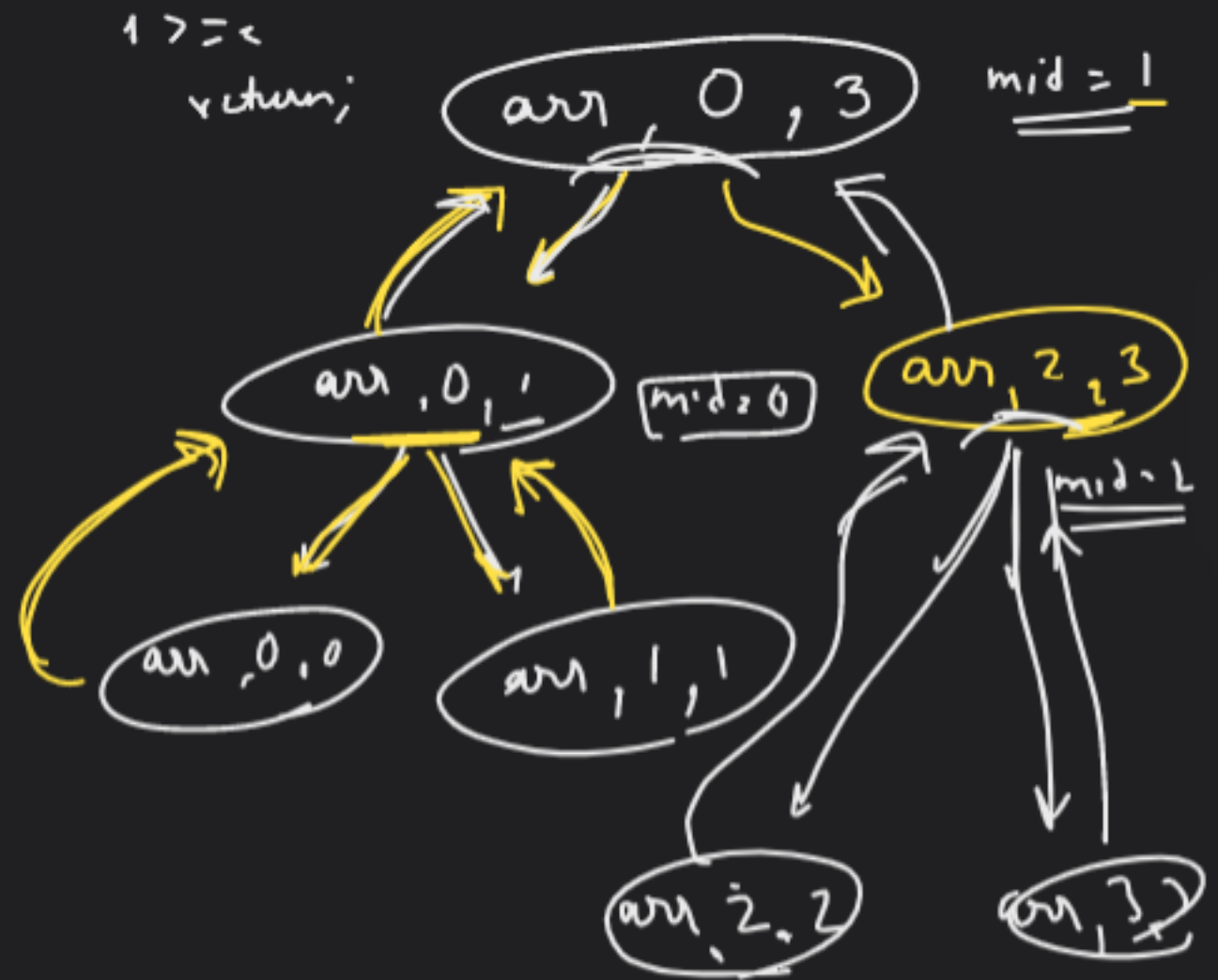
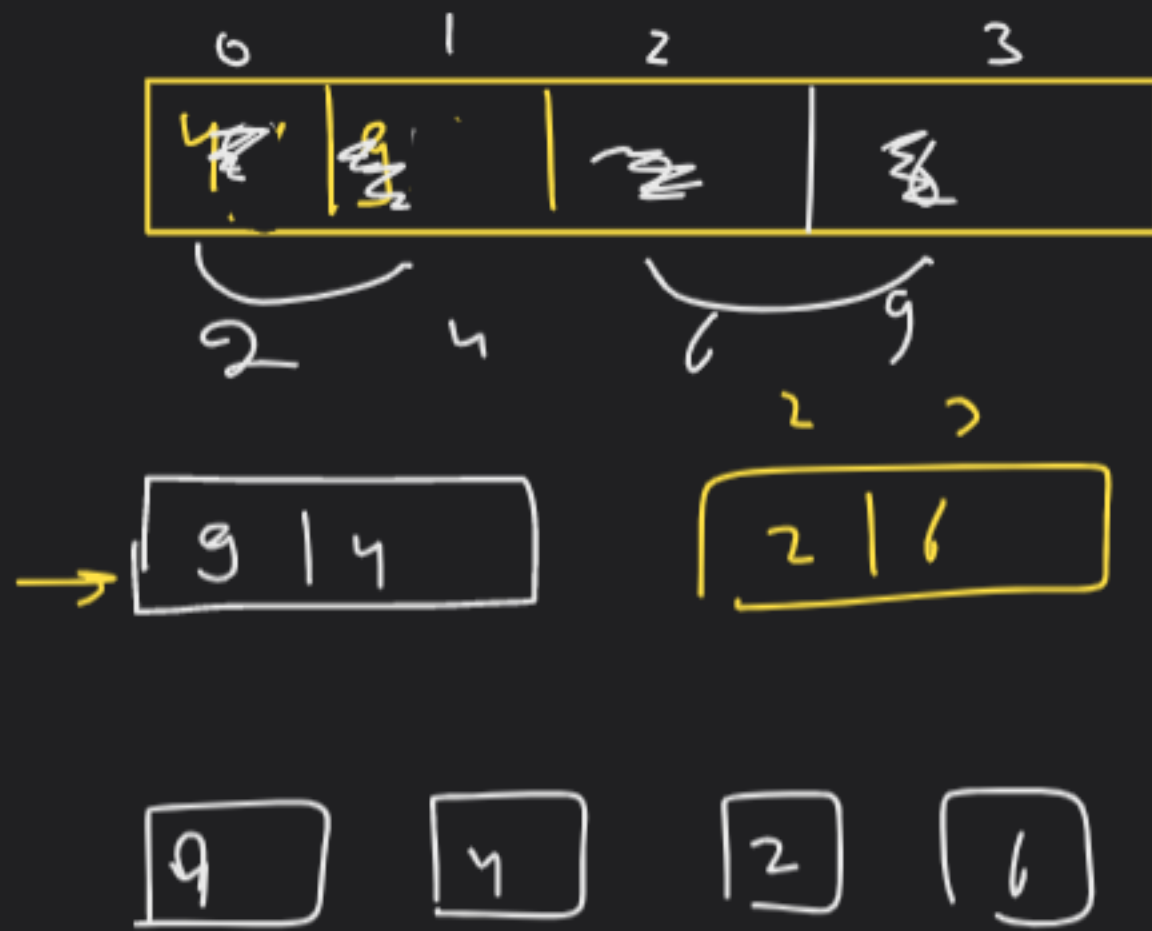


$\rightarrow \text{mid}(\frac{l+r}{2}) = 1$



$\text{mid} = 0 \text{ to } 0$





9 | 2 | 4 | 6

9 | 2

4 | 6

2 | 9

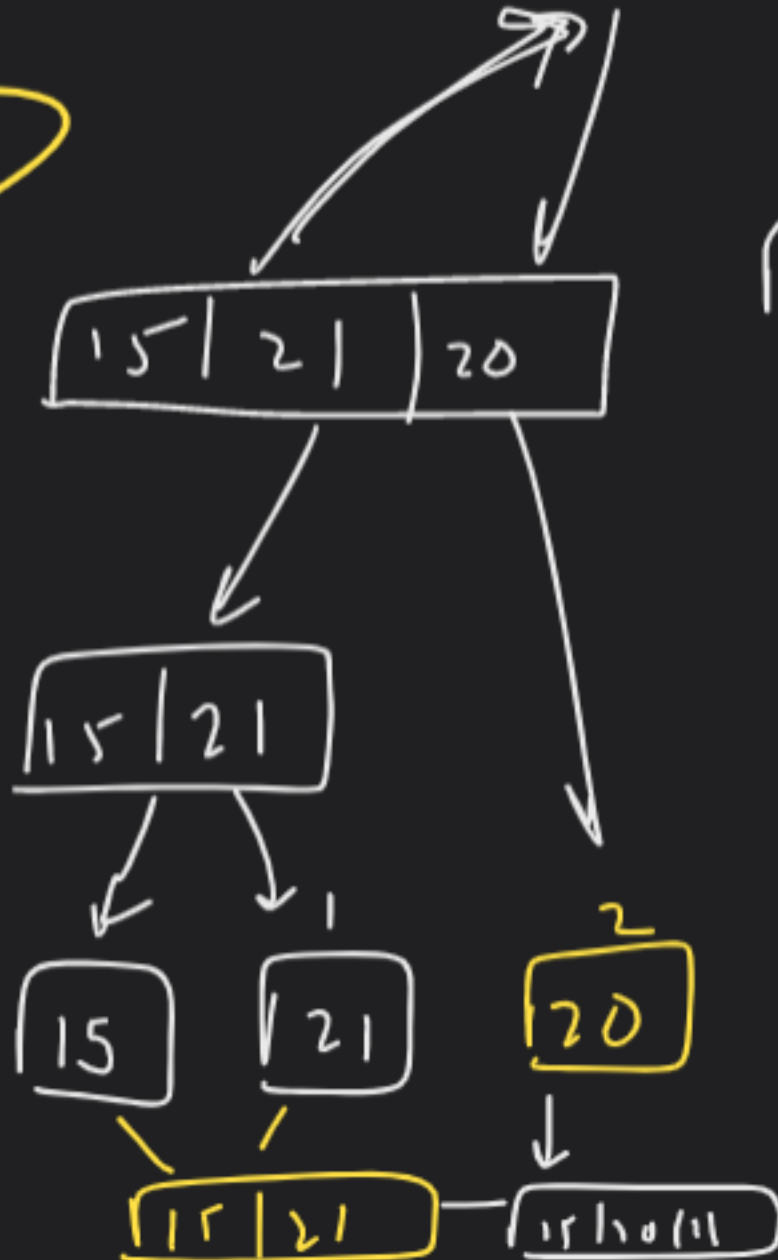
4 | 6

2 | 4 | 6 | 9

0	1	2	3	4	5
15	20	20 21	4	19	17

$1 > = <$
return

2hr
2.5hr



$4 \mid 19 \mid 17$



Binary Search

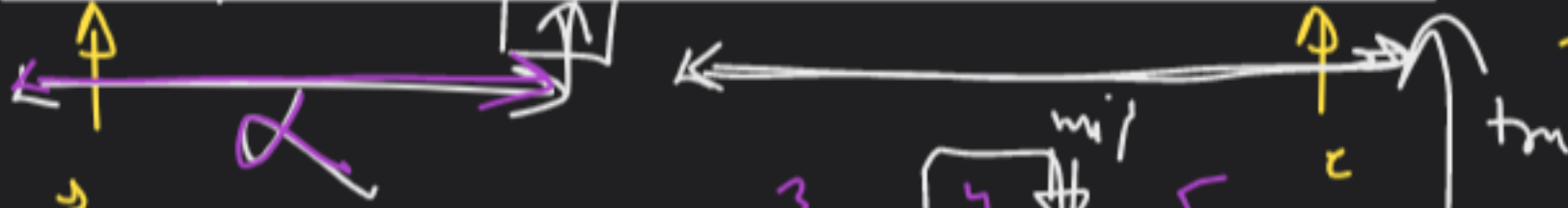
non monotonic function/ array

1 min
break

target = 9

$$\begin{aligned} \text{mid} &= \frac{l+r}{2} \\ &= \frac{0+5}{2} \\ &= 2 \end{aligned}$$

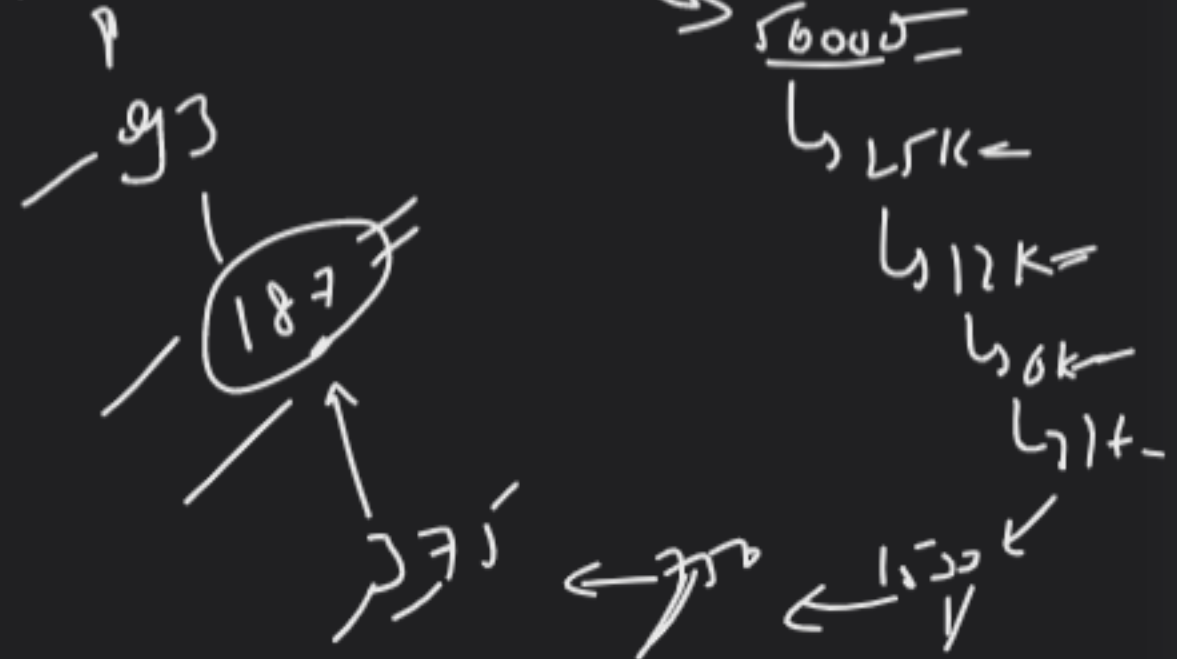
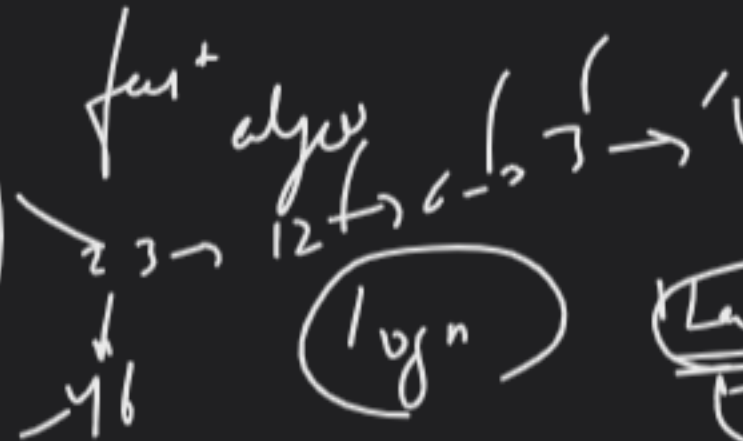
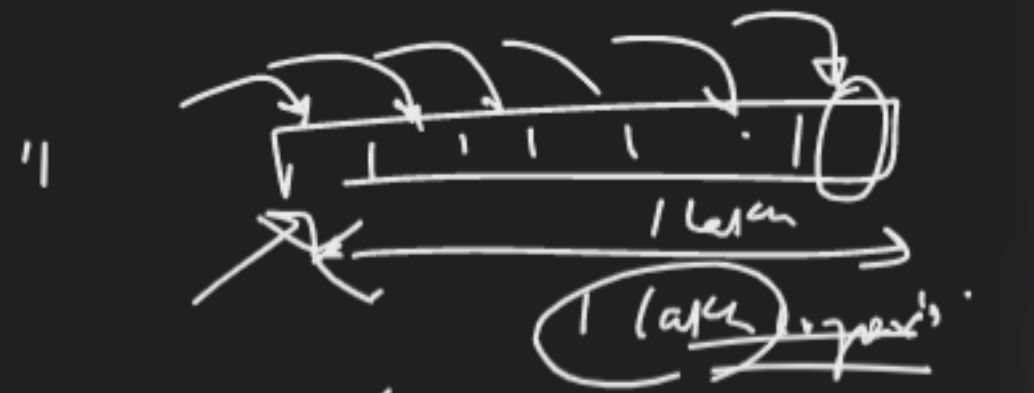
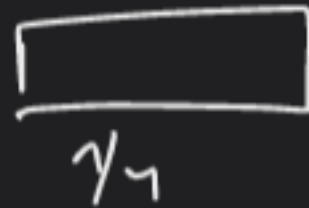
0	1	2	3	4	5
2	4	7	9	11	14

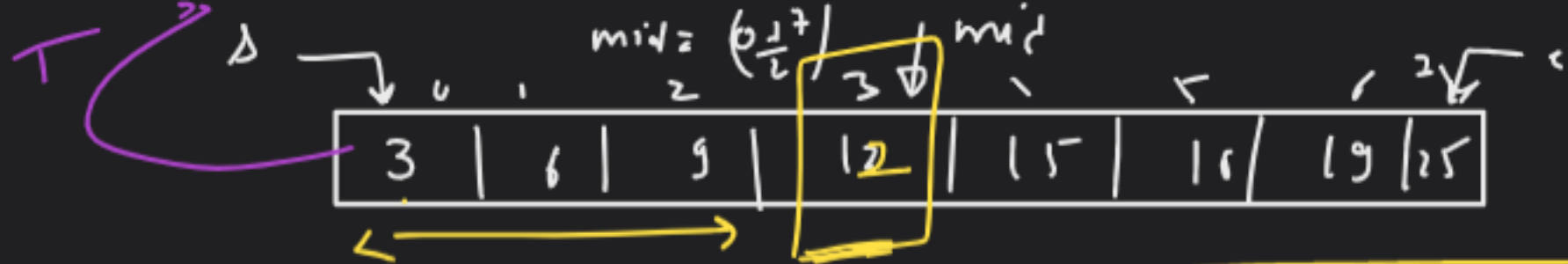


3	4	5
9	11	14

$$\begin{aligned} \text{mid} &= \frac{3+5}{2} \\ &= 4 \end{aligned}$$





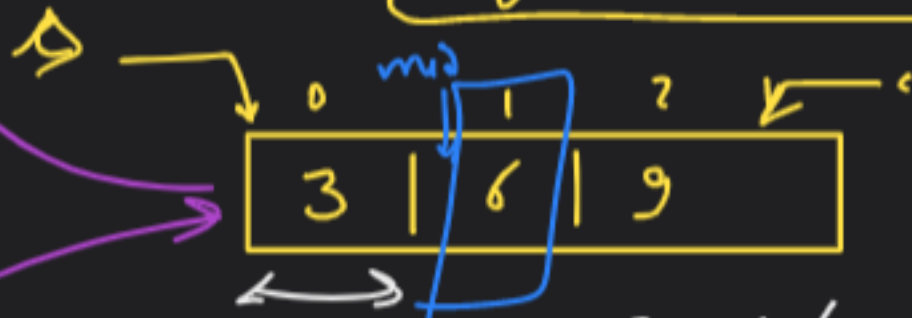


3 \rightarrow target

T

target < arr[mid] \rightarrow search in left
 target > arr[mid] \rightarrow search in right
 target == arr[mid] \rightarrow return true

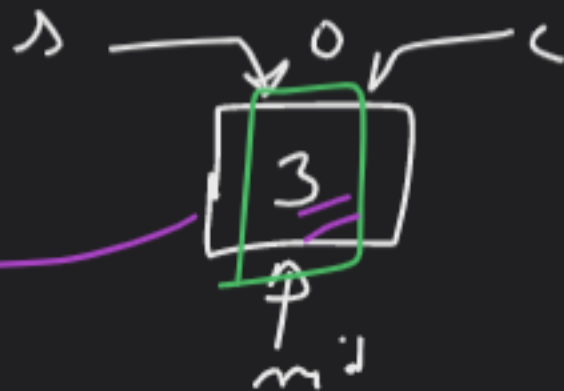
3 < 12
 \downarrow
 left



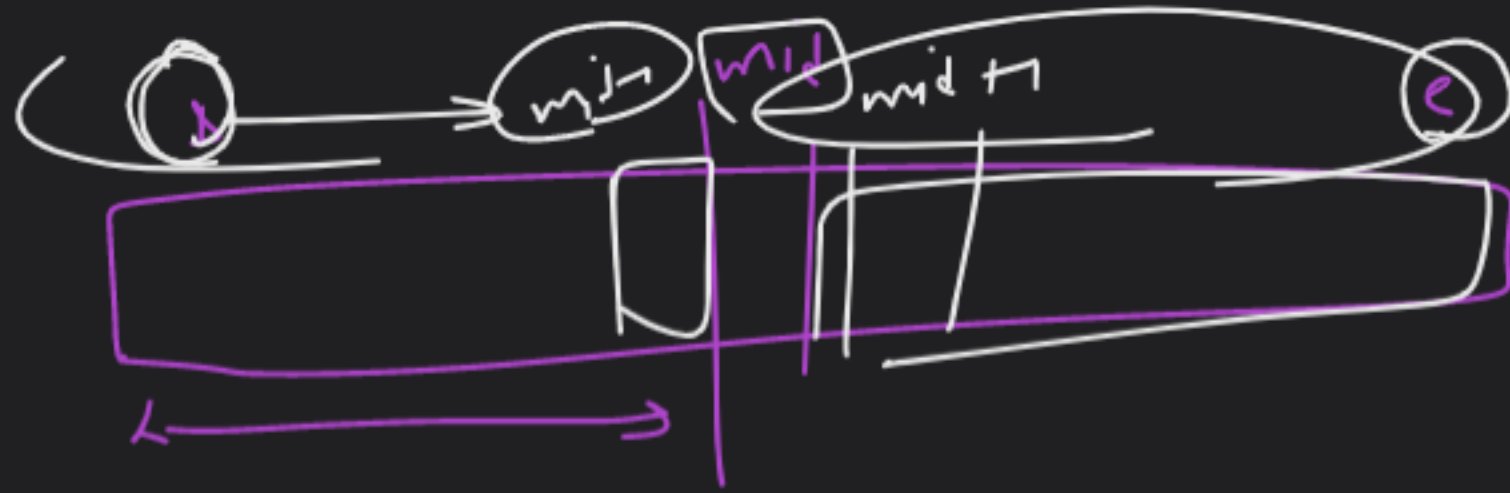
$$mid = \frac{0+2}{2} = 1$$

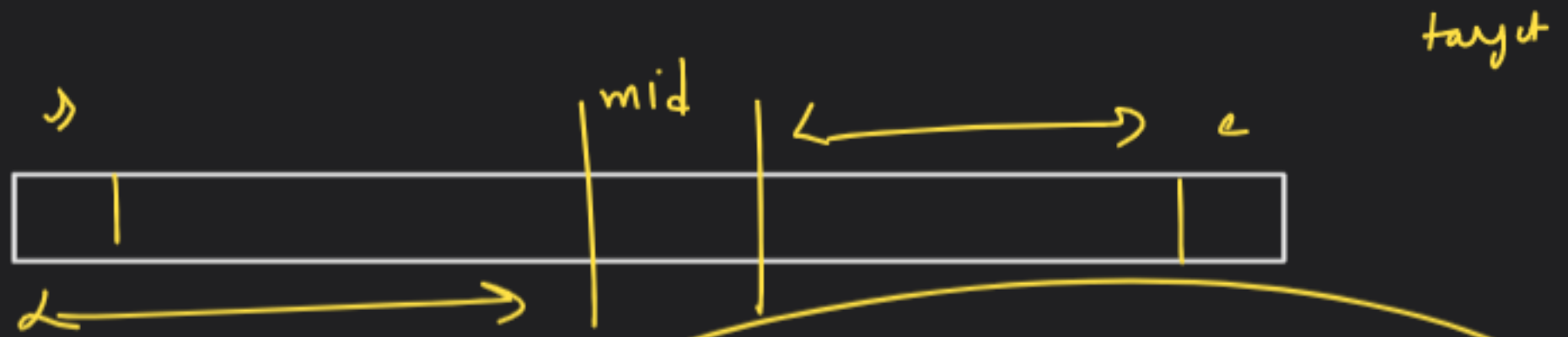
3 < 6 \rightarrow

$$mid = \frac{0+0}{2} = 0$$



3 == 3





$\text{target} = \text{arr}[\text{mid}] \rightarrow \underline{\underline{\text{found}}}$

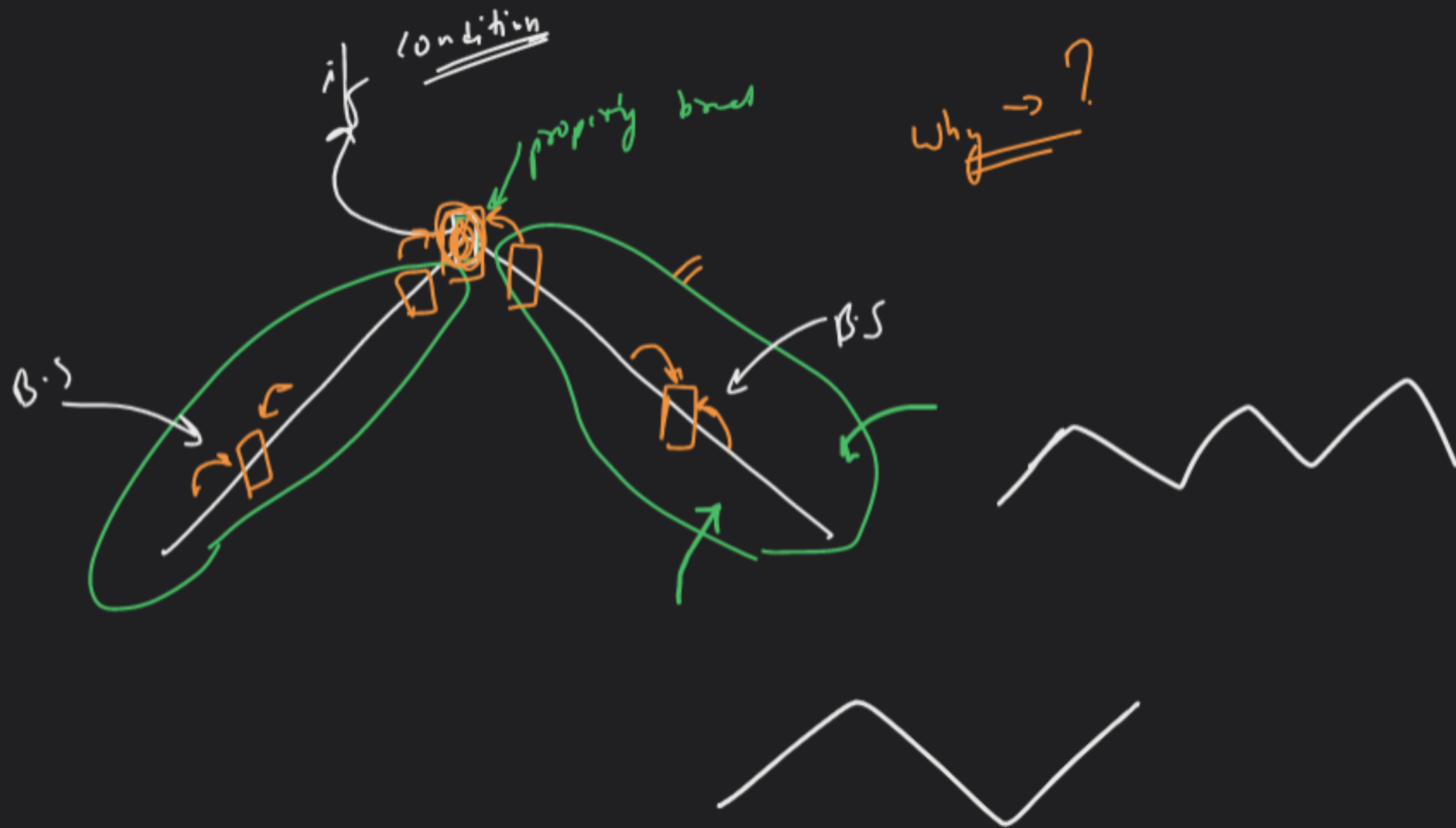
Not found

$\text{target} < \text{arr}[\text{mid}] \rightarrow \text{search in left}$

$\text{target} > \text{arr}[\text{mid}] \rightarrow \text{search in right}$



map <int, bit <int>>:





1 0 0

5-1

6-1



4+1=5