

18/9/23

Week  $\rightarrow$  4

A.P.E.O.  
Date: 22/5

## class $\rightarrow$ 2 Searching

Agenda

↳ B.S  $\rightarrow$  monotonic function  $\rightarrow$  asc  
 $\rightarrow$  dec

↳ T.C.  $\rightarrow O(\log n)$   
 $\hookrightarrow$  size of array

1024 size array  $\rightarrow$  10 operation of B.S

Q) Find Pivot element

↓  
Sub question of search in a rotated  
2 sorted array

Sorted  $\rightarrow$  [2 | 4 | 6 | 8 | 10 | 12 | 14 | 16]

rotated & sorted  $\rightarrow$  [12 | 14 | 16 | 2 | 4 | 6 | 8 | 10]  
↑ Increasing      ↑ Increasing

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inc

inc

APCS  
Date: 02/06

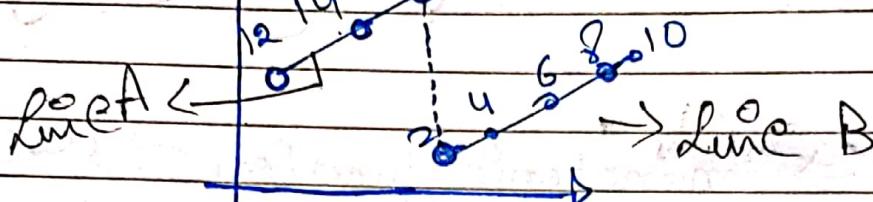
12	14	16	2	4	6	8	10
0	1	2	3	4	5	6	7

arr

0 1 2 3 4 5 6 7

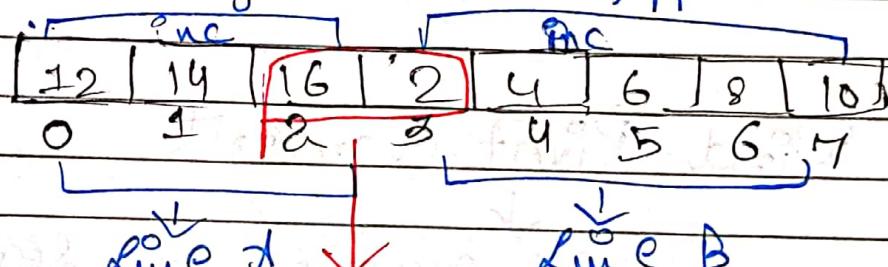
Pivot

Handle them



Approach → i) L.S. →  $O(n)$   
ii) sort →  $O(n \log n)$

(iii) B.O.S. →  $O(\log n)$  → Best approach



separately handle

If

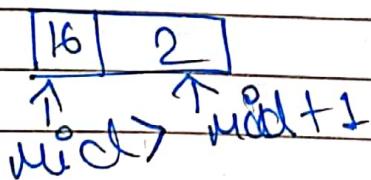
mid=2 arr[mid] < arr[mid-1]

↳ True → mid-1 → return

(ii) If mid=16

arr[mid] > arr[mid+1]

↳ ans = mid

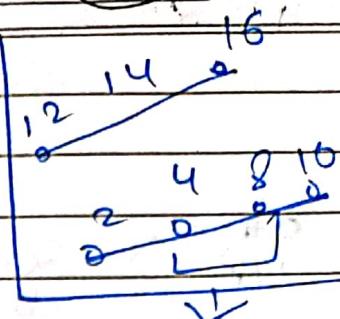


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we are on B

iii) Line B  $\rightarrow$  arr[mid] < arr[s] $\hookrightarrow$  Left

$$e = mid - 1;$$



close

 $\hookrightarrow$  right ( $s = mid + 1$ )

Line B

every

Element in B  
is smaller  
than start

Code  $\rightarrow$ 

```
int findPivotIndex (arr[], n)
int s = 0, e = n - 1, mid = (s + e) / 2;
```

while ( $s \leq e$ ) {

if (arr[mid] &lt; arr[mid - 1])

return mid - 1;

if (arr[mid] &gt; arr[mid + 1])

return mid;

else if (arr[s] &gt; arr[mid])

 $e = mid - 1;$ else  $s = mid + 1$  ;

{}

$\star \rightarrow$   $\neg$  if ( $s == e$ ) return s/e /mid;

single element case

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## Search in a Rotated & Sorted Array

i/p  $\rightarrow$  sorted  $\rightarrow$  

Rotated  
Target = 14       $\leftarrow 12 \text{ to } 16 \rightarrow$        $\leftarrow 2 \text{ to } 10 \rightarrow$   
 ↓                  ↓ is meata hh

// Search in A

$\rightarrow$  If ( $\text{target} \geq \text{arr}[0]$  & &  $\text{target} \leq \text{arr}$ )  
 [pivot]

ans = binary search (num, target, 0, pivot index)

else if ( $\text{target} \geq \text{arr}[\text{pivot} + 1]$  & &  
 $\text{target} \leq \text{arr}[\text{n}-1]$ )

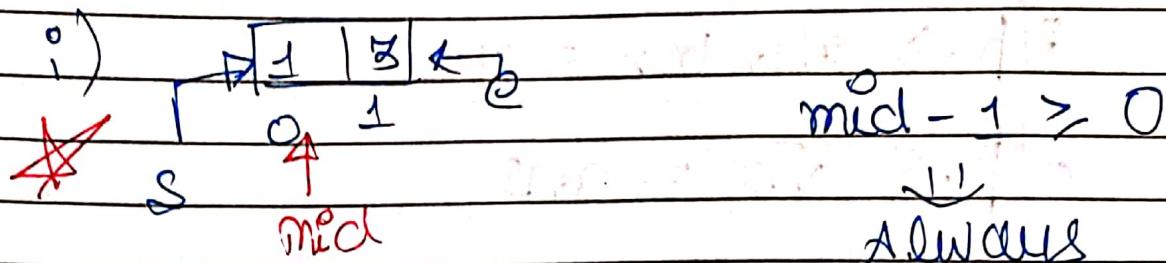
ans = b&(num, target, pivot+1, n-1)

Ampt

16/9/23 Pivot Index

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Adding some cases



↓  
Always

ii)  $\text{mid} + 1 \leq n - 1 \rightarrow \text{always}$

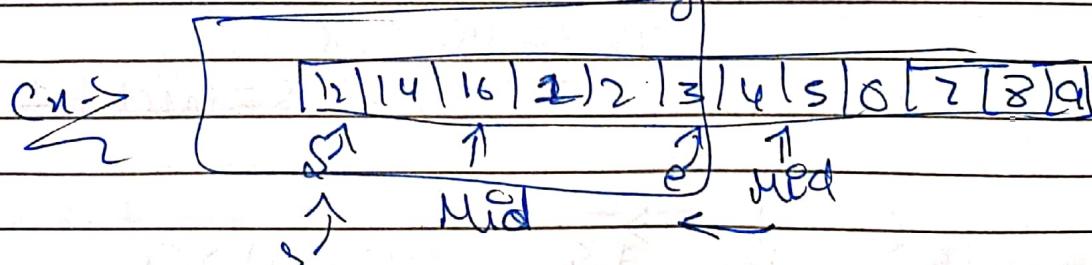
→ We forgot about these condn  
on Page → 227

Also

ans)

↓  
If element is  
on line A

then always  $e = \text{mid} - 1$



Start some Rhegar Tok  
 $s \rightarrow 0$   $\text{hi} \rightarrow 10$   $\text{Na ki} \rightarrow 10$   $\text{a ve} \rightarrow 10$

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### Q) $\text{Sqrt}(x)$

i/p  $\rightarrow$  Number =  $n$

o/p  $\rightarrow \sqrt{x} = \text{ans}$

$\rightarrow 25$

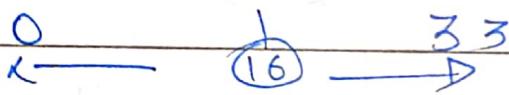
$\hookrightarrow \sqrt{25} \rightarrow 5$

- i/p  $\rightarrow 68$

$\hookrightarrow$  Ab is root will always be  
b/w  $0 - \underline{\underline{34}} - \dots - 68$   
Search space

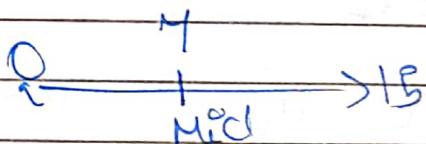
$$34 \times 34 = 68$$

$\hookrightarrow$  NO  $\rightarrow$  goto Left  $\rightarrow e = \text{mid} - 1$



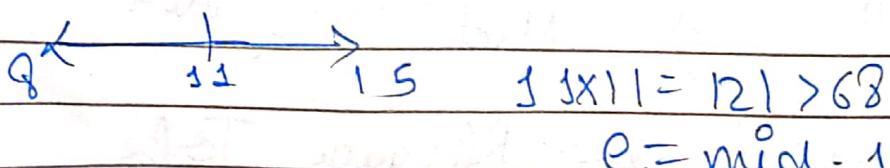
$$\hookrightarrow 16 \times 16 = 256 > 68$$

$\hookrightarrow$  Left  $\rightarrow e = m - 1$



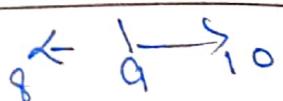
$$7 \times 7 = 49 < 68$$

$\hookrightarrow$  false  $\rightarrow s = \text{mid} + 1$



$$13 \times 13 = 169 > 68$$

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



$$9 \times 9 = 81 > 68$$

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

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$$\begin{array}{c} 8 \\ \swarrow \uparrow \searrow \\ 8 \end{array}$$

mid

$$8 \times 8 = 64 \rightarrow \text{false}$$

$$18 * 8 > 68 \rightarrow \text{false}$$

$$8 \times 8 < 68$$

less than value can be  
store ans

Why?

$$\text{Ex- } 4 \times 4 = 16$$

$$4 \times 4 = 16 \rightarrow \checkmark$$

$$\text{Ex- } 20$$

$$4 \times 4 = 16 < 20, 5 \times 5 = 25 > 20$$

Ab  $\rightarrow 5^2$  Bda h 20 se Tok 5. something

5 point something hmesha

bda Rhesaa

Lekin  $\rightarrow 4.1$

$4.2$  ]  $\rightarrow$  These value can be  
 $4.3$  equal to 20

Chote No se Bada ho jayega Tok  
Ans Mil Jayega

$$\begin{array}{l} \text{H/W} \rightarrow \text{int } r = 20 \\ \sqrt{20} = 4.171 \text{ find this} \\ \text{decimal places} \end{array}$$

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## Binary Search on 2-D Array - ↴

	0	1	2	3	
0	2	4	6	8	→ every Row sorted
1	10	12	14	16	→ every Next row
2	18	20	22	24	↓ last row
3	28	34	40	50	last elme



| 2 | 4 | 6 | 8 | 10 | 11 | 14 | 16 | 18 | 20 | 22 | 24 | 28 | 34 | 40 | 50 |

$$2D \rightarrow 1D = (C * i) + j$$

$$1D \rightarrow 2D \rightarrow i = \frac{\text{Mid}}{C}, j = \text{Mid} \% C$$

(S-1) → In memory 2-D array is stored as 1-D,

(S-2) → Apply formula to find Mid

(S-3) → Then convert it into i & j using  $i = \frac{\text{Mid}}{C}$ ,  $j = \text{Mid} \% C$

(S-4) → From this we get current number  $\text{curr} = \text{target} \rightarrow \text{return mid}$

find out Mid  
using Mid

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curr N > Target  $\rightarrow e = mid - 1$

curr N < Target  $\rightarrow s = mid + 1$

$\Rightarrow$  If target == curr N  $\rightarrow$  target

$\rightarrow$  we know current number  
Return its index

$\rightarrow$  using  $i$  &  $j$

$\rightarrow$  Already find out using  
mid

H/W  $\rightarrow$  Explained in H-W Copy

$\therefore \rightarrow$  Main element

[12 | 14 | 16 | 12 | 14 | 6 | 8 | 10]

[16 | 2]  
 $\uparrow$   
mid

$\rightarrow$  Mid > Mid + 1  $\rightarrow$  return Mid + 1

$\rightarrow$  Mid < Mid - 1  $\rightarrow$  return Mid

else if ( $arr[s] < arr[mid]$ )  $\rightarrow$  we are  
 $s = mid + 1$

else  $\rightarrow e = mid - 1$

If ( $e == s$ )  $\rightarrow$  return mid

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② → sqrt in Decimal

Pg → 236

→ closest ans in Int

Int ans = final\_sqrt(x);

precision ← Input user se

↳ For how many decimal places

You want 800M

Step = 0.5;

for(i = 0; i < precision; i++)

double

fA = ans

for(j = fA; j \* j <= x; j += step)

fA = j

step / = 10;

cout << fA

j = 8, 8 \* 8 ≤ 68 → yes ; j += step

fA = 8

$$8 + 0.1 = 8.1 \times 8.1 \leq 68$$

fA = 8.2

$$8 + 0.2 = 8.2 -$$

like chalta jagga

→ phlel  $\rightarrow$  ~~free place~~

On  $i = t$

$\rightarrow$  ~~free place~~

→ dpe Answer find ho jayega  
jo closest hoga