BS 02

09 February 2025 08:57

Array =

0	1	2	3	4	5	6
2	4	5	7	9	12	15

l, mid, r

key = 12

12 > 7

12 > 5

12 > 4

12 > 2

$mid = \frac{l+r}{2} = \frac{6+0}{2} = 3$

1. arr[mid] == key
   - return mid;
2. arr[mid] > key ⇒ 7 > 2
   - r = mid - 1
3. arr[mid] < key
   - l = mid + 1

1 Lower Bound of Array

The smallest index where arr[ind] >= x.
(If no index is found, this algorithm will return the size of array.)

Array =

0	1	2	3	4	5	6	7
2	3	7	9	15	22	25	29

x = 15

x = 22

x = 26

$x = 15$

$arr[ind] \geq x \Rightarrow$ 4

$x = 22$

ind = 5

$x = 26$

ind = 7

Solution - 1 Using Linear Search

Smallest index where $arr[ind] \geq x$

Array =

0	1	2	3	4	5	6	7
2	9	9	9	9	21	25	29

l, r

$x = 9$

$mid = \frac{l+r}{2} = \frac{0+7}{2} = 3$

$arr[mid] \geq x$

$9 \geq 9$

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

(1) $arr[mid] \geq x$

→ Store mid.

→ $r = mid - 1$

(2) $arr[mid] < x$

→ $l = mid + 1$

Ans ⇒ ~~3~~ 1

(2) Upper Bound

Smallest Index which has $arr[ind] > x$

Array =

0	1	2	3	4	5	6	7
2	3	7	9	9	9	25	29

$x = 8, 15, 9$

ans = 3, 5, 6

(2) Using Binary Search

$x = 9$

Array =

0	1	2	3	4	5	6	7
2	3	7	9	9	9	25	29

l ↑ mid ⇑ r ↑

$mid = \frac{0+7}{2} = 3$

$arr[mid] <= x \Rightarrow l = mid + 1$

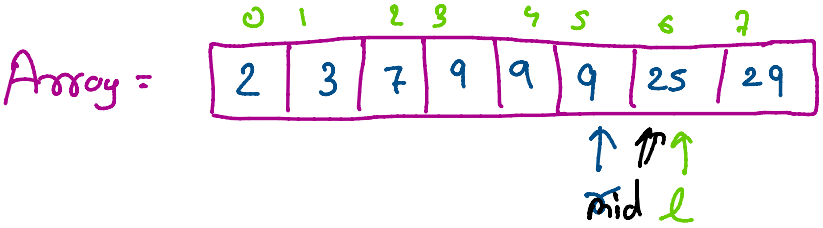
Array =

0	1	2	3	4	5	6	7
2	3	7	9	9	9	25	29

l ↑ mid ⇑ r ↑

$mid = \frac{4+7}{2} = 5$

arr[mid] <= x : l = mid + 1



mid = $\frac{6+9}{2} = 6$

arr[mid] > x :

Store the ans

r = mid - 1

⇒ Questions

34. Find First and Last Position of Element in Sorted Array

Solved

Medium | Topics | Companies

Given an array of integers `nums` sorted in non-decreasing order, find the starting and ending position of a given `target` value.

If `target` is not found in the array, return `[-1, -1]`.

You must write an algorithm with `O(log n)` runtime complexity.

Example 1:

> **Input:** nums = [5,7,7,8,8,10], target = ~~8~~ 5
> **Output:** [3,4] [0,0]

Example 2:

> **Input:** nums = [5,7,7,8,8,10], target = 6
> **Output:** [-1,-1]

Example 3:

> **Input:** nums = [], target = 0
> **Output:** [-1,-1]

Sol (1) Using a Linear Search (No Extra Arrays)

first = ~~-1~~ 3

last = ~~-1 3 4 5~~ 6

target = 6

0	1	2	3	4	5	6	7	8
1	3	5	6	6	6	6	7	9

Sol (2) Using Binary Search

0	1	2	3	4	5	6	7	8
1	3	3	3	6	6	7	7	9

x = 3

Ans = {1, 3}

x = 7

x = 6 ?

Lower_Bound = 1 , 6

Upper_Bound = 4-1 = 3 , (8-1) = 7

⇒ Question

Number of occurrence

Difficulty: **Easy** Accuracy: **59.34%** Submissions: **295K+** Points: **2** Average Time: **20m**

Given a **sorted** array, **arr[]** and a number **target**, you need to find the number of occurrences of **target** in **arr[]**.

Examples :

Input: arr[] = [1, 1, 2, 2, 2, 2, 3], target = 2
Output: 4
Explanation: target = 2 occurs 4 times in the given array so the output is 4.

Input: arr[] = [1, 1, 2, 2, 2, 2, 3], target = 4
Output: 0
Explanation: target = 4 is not present in the given array so the output is 0.

35. Search Insert Position

Solved

Easy Topics Companies

Given a sorted array of distinct integers and a target value, return the index if the target is found. If not, return the index where it would be if it were inserted in order.

You must write an algorithm with `O(log n)` runtime complexity.

Example 1:

```
Input: nums = [1,3,5,6], target = 5
Output: 2
```

Example 2:

```
Input: nums = [1,3,5,6], target = 2
Output: 1
```

69. Sqrt(x)

Easy | Topics | Companies | Hint

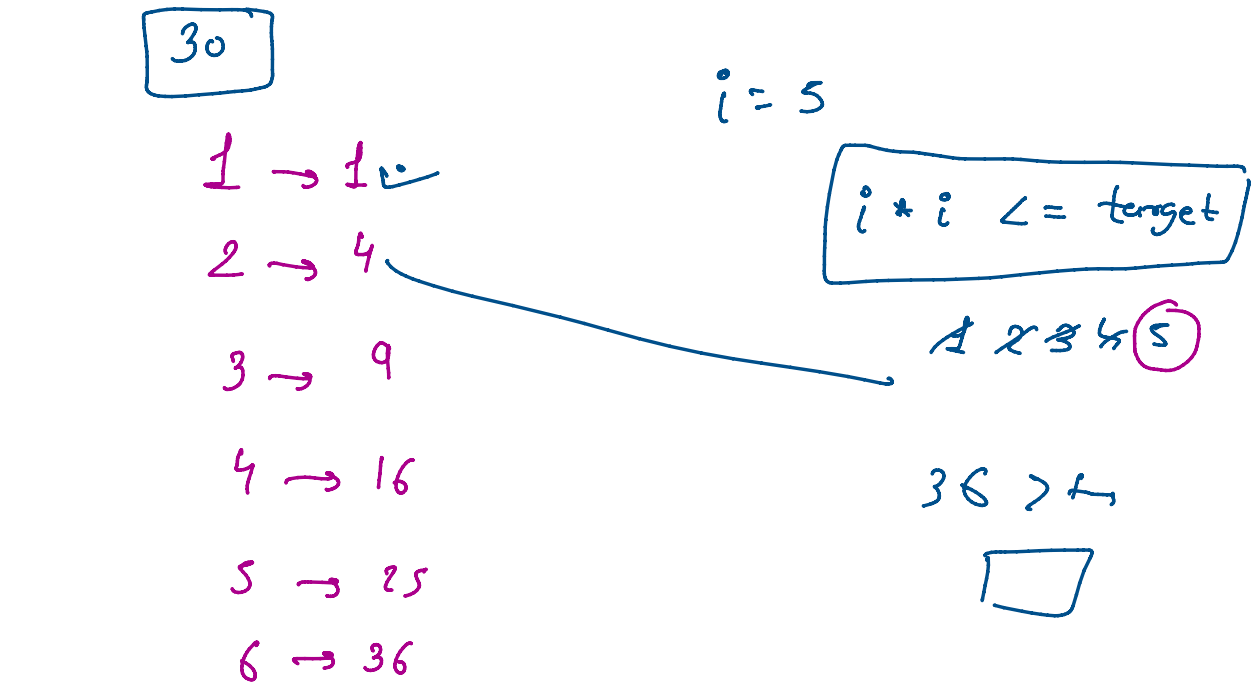
Given a non-negative integer `x`, return *the square root of* `x` *rounded down to the nearest integer*. The returned integer should be **non-negative** as well.

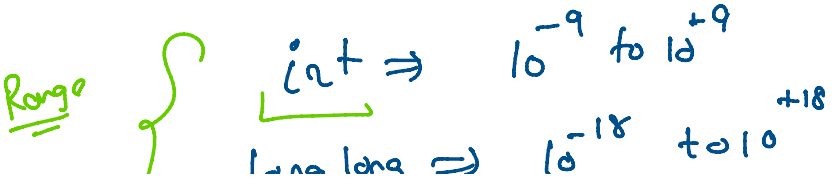
You **must not use** any built-in exponent function or operator.

- For example, do not use `pow(x, 0.5)` in c++ or `x ** 0.5` in python.

Example 1:

```
Input: x = 4
Output: 2
Explanation: The square root of 4 is 2, so we return 2.
```





Range { long long ⇒ 10^{-18} to 10^{+18}

⇒ How to use Binary Search?

Sort ⇒ 9

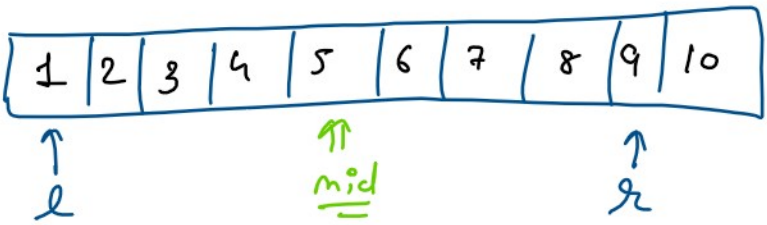
B.S { Sorted
left, right ⇒ mid
Conditions on mid

left = 1

right = 9

$mid = \frac{l+r}{2} = \frac{1+9}{2} = 5$

mid * mid ⇒ 25

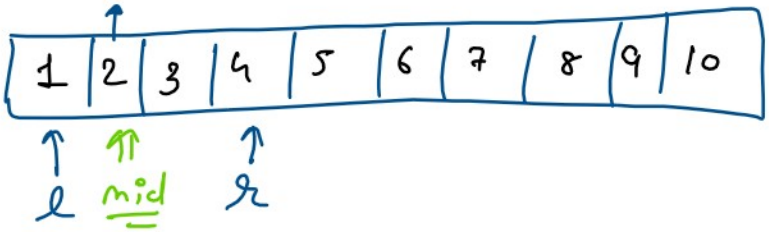


left = 1

right = 4

$mid = \frac{l+r}{2} = \frac{1+4}{2} = 2$

mid * mid ⇒ 4



mid ≤ target

Store → mid

left = 3

"Imaginary Array"

left = 3

right = 4

$mid = \frac{l+r}{2} = \frac{3+4}{2} = 3$

mid * mid ⇒ 9

mid ≤ target

store → mid

l = mid + 1

Imaginary Array