# Searching

## Agenda

- Linear Search
- Binary Search
- Square root

# Linear Search

Given an array of numbers and a target value, find the index of the target value. Return -1 if it is not present in the array.

**Example 1**

target = 3

| 10 | 12 | 8 | 2 | 9 | 3 | 4 |
|---|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 |

ans = 5

**Example 2**

target = 6

| 10 | 12 | 8 | 2 | 9 | 3 | 4 |
|---|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 |

ans = -1

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In worst case

N iterations

Array - Size N

# Binary Search

Binary Search is a Divide and Conquer technique.

## Prerequisite

- Array must be sorted

## Algorithm

- Find the middle element and compare it with x.
- If middle element is equal to x, end the search. You found the element.
- If middle element is greater than x, search for x in left half.
- If middle element is less than x, search for x in right half.
- Repeat the above steps till you find x, or till you exhaust the array.

Dictionary → Words in sorted order

"pen"

1st method - Going starting to end - all the words

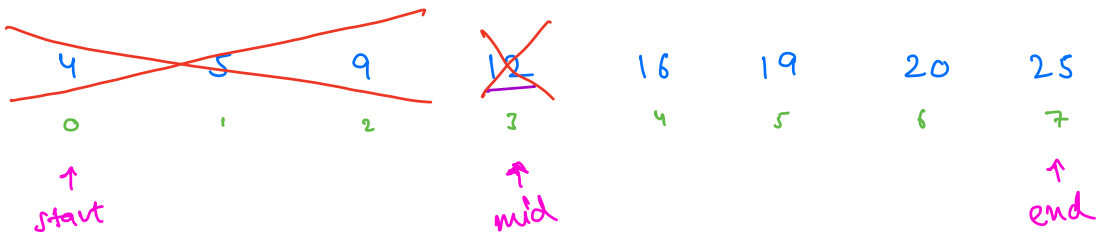
2nd method - Going to the mid, picking a direction

↳ faster

## Example 1

Sorted away

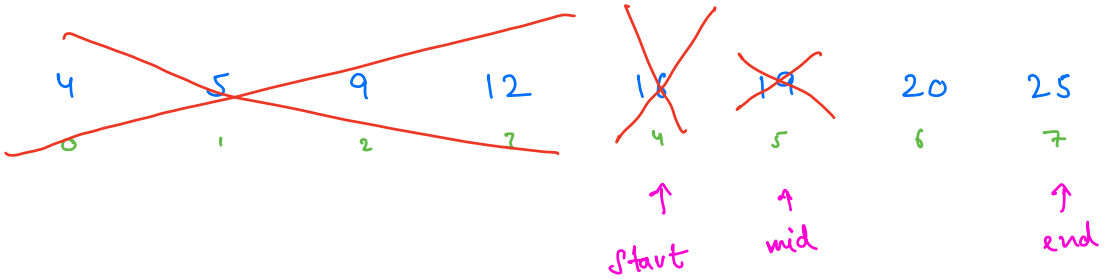
target = 20




if 12 == target?

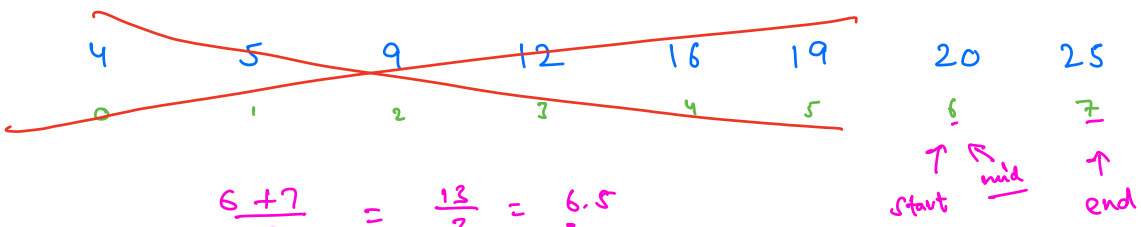
12 < 20

if ( midValue < target )
start = mid + 1




if 19 == 20 ?

19 < 20



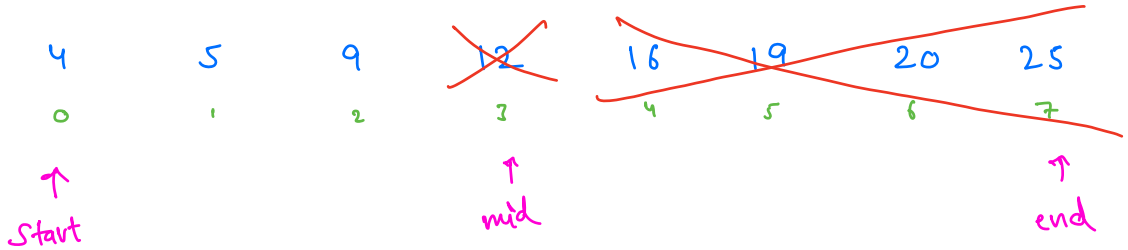

$\frac{6+7}{2} = \frac{13}{2} = 6.5$

if 20 == 20 ?

return mid → 6

Example 2

target = 9



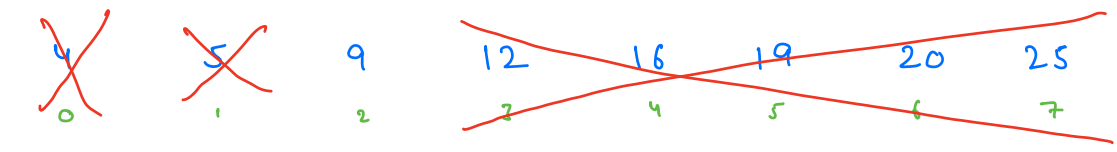

12 == 9

12 > 9

Eliminate right part

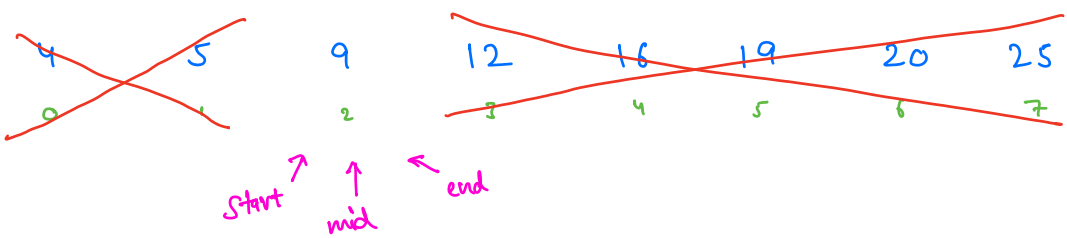
if ( midValue > target )

end = mid - 1



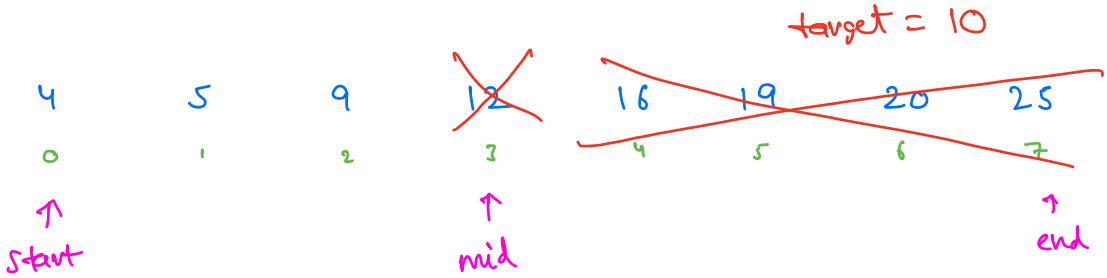

5 == 9 ?

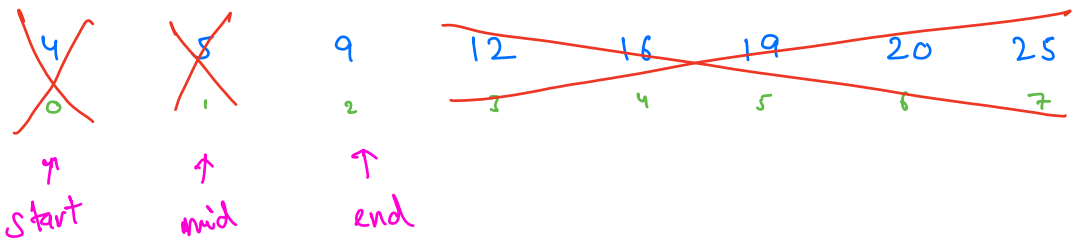
5 < 9

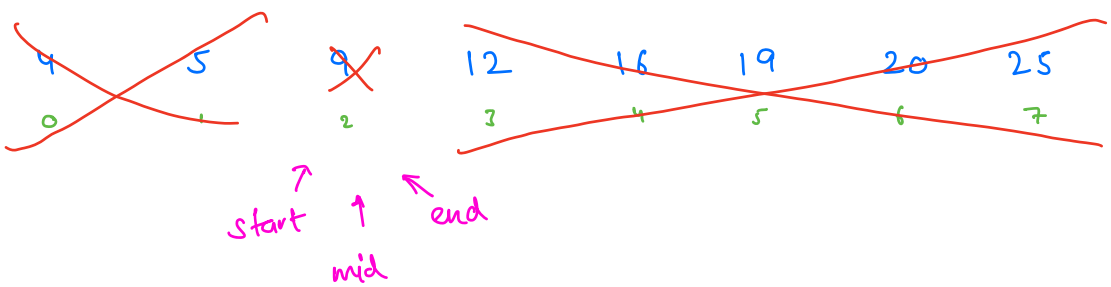



9 == 9 ?

ans = 2



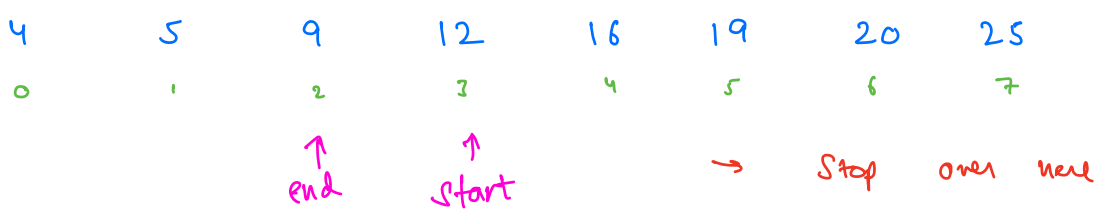




$9 == 10$ ?

$9 < 10$

midVal < target




start <= end

# Square root

Given a perfect square number, find its square root.
(Do not use any inbuilt functions)

N = 100 → 10

N = 49 → 7

N = 64 → 8

N = 20 → Invalid Input

N = 1 → 1

Range → 1 to N

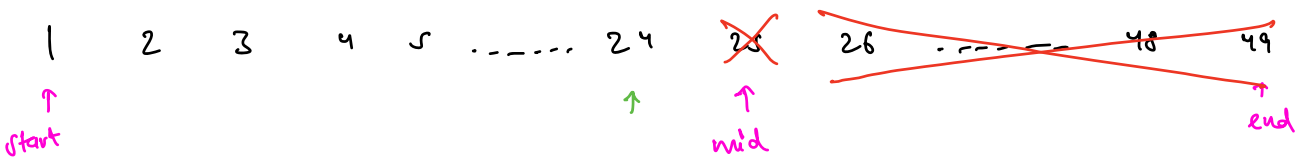
N = 100


if $50^2 == 100$

2500 > 100

Go left

end = mid - 1

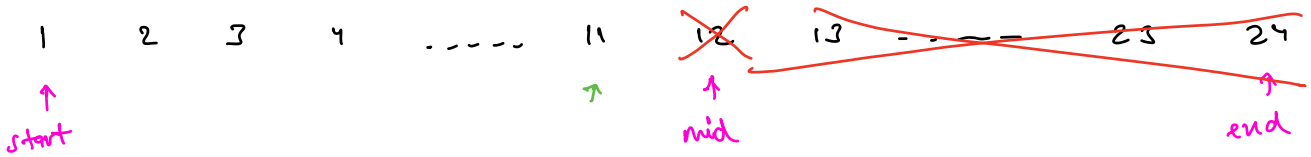



if $25^2 == 100$

625 > 100

Go left

end = mid - 1




end = mid - 1

if 144 == 100

144 > 100

Go left


if 36 == 100

36 < 100

Go right

start = mid + 1


81 == 100

81 < 100

Go right

start = mid + 1


$10^2$ == 100 ?

ans = 10

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target : 3


1st iteration

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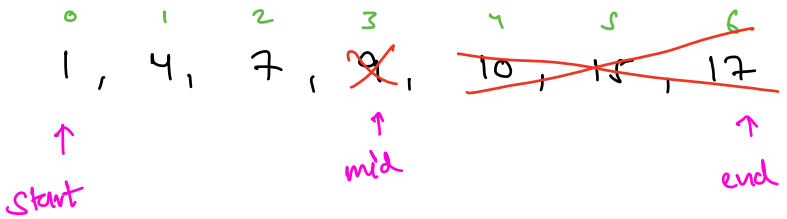
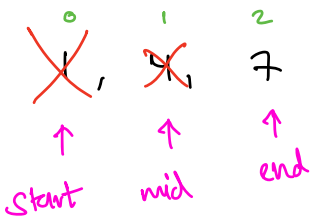
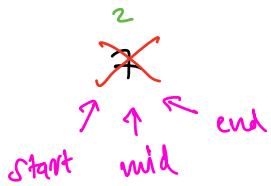



target = 6

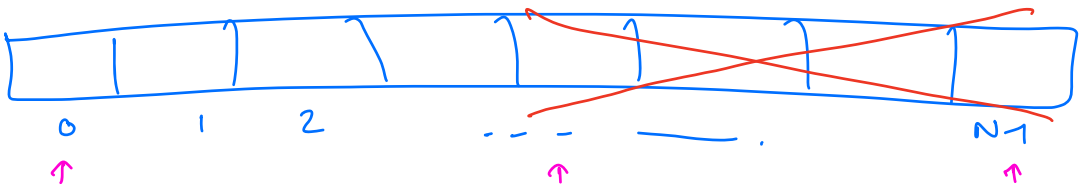



3 iterations

Array of size N

Size of search space




At each step, we eliminate half of our array.

↓

We reduce our search space to half size.

$N \rightarrow \frac{N}{2} \rightarrow \frac{N}{4} \rightarrow \frac{N}{8} \rightarrow \frac{N}{16} \cdots\cdots 1$

k steps

How many steps ??

→ Assume it takes k steps

$N \rightarrow \frac{N}{2} \rightarrow \frac{N}{4} \rightarrow \frac{N}{8} \rightarrow \frac{N}{16} \cdots\cdots 1$

$0^{th}$ step, $1^{st}$ step, $2^{nd}$ step, $3^{rd}$ step, $4^{th}$ step, $k^{th}$ step

$$\frac{N}{2^0} \rightarrow \frac{N}{2^1} \rightarrow \frac{N}{2^2} \rightarrow \frac{N}{2^3} \rightarrow \frac{N}{2^4} \cdots\cdots \frac{N}{2^k}$$

$$\frac{N}{2^k} = 1$$

$$\Rightarrow \quad N = 2^k$$

Taking $\log_2$ both sides

$$\log_2 N = k$$

Binary search will take approx $\log_2 N$ iterations in worst case

# Doubts

Thank You

DSML Oct 22 Beginner Mon 2
Mon 3

NLP Module → Natural Language Processing

Good Night

Thank You

Monday