

First and last position

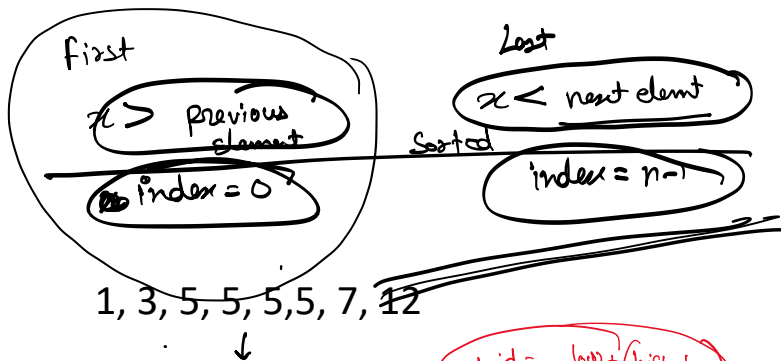
$\downarrow \downarrow \downarrow \downarrow \downarrow$
 $arr = 5 \dots \uparrow$
 $first = 1 = 2$
 $last = 5$
 $return = [2, 5]$

$O(n)$

```

def first_last(arr, x):
    first = -1
    last = -1
    for i in range(len(arr)):
        if (x != arr[i]):
            continue
        if (first == -1):
            first = i
        last = i
    return [first, last]
    
```

$x=5$



$$mid = low + \frac{high - low}{2}$$

- First**
- low high
 - loop $high \geq low$
 - $mid = \frac{low + high}{2}$
 - $x > arr[mid]$
 $arr[mid] == x$
 $mid == 0$

⑤ if $x > arr[mid]$
 $low = mid + 1$
 else
 $high = mid - 1$

- Last**
- low high
 - loop $high \geq low$
 - $mid = \frac{low + high}{2}$
 - $x == arr[mid]$
 $arr[mid+1] > x$
 $mid == n-1$

if $x < arr[mid]$
 $high = mid - 1$
 else
 $low = mid + 1$


```

def last(arr, x):
    n = len(arr)
    low = 0
    high = n-1
    res = -1
    while low <= high:
        mid = (low+high)//2
        if arr[mid] > x:
            high = mid - 1
        elif arr[mid] < x:
            low = mid+1
        else:
            res = mid
            low = mid + 1
    return res

```

$n = 10$
 1, 2, 2, 2, 2, 3, 4, 7, 8, 8

target = 8

low = 0

high = 9

~~mid = 5~~

mid = 8

~~result = 8~~

result = 9

target = 8

arr[mid] = 8

mid = 9

arr[mid] = 8

target = 8