

First and last position

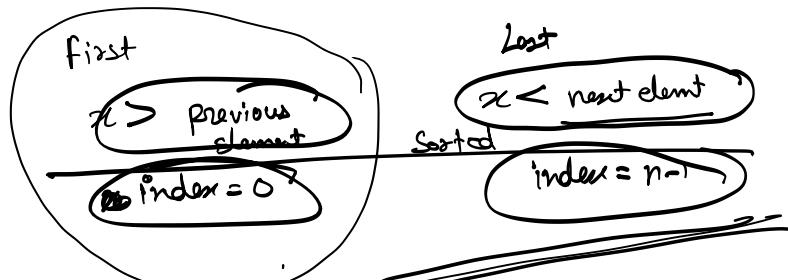
```
def first_last(arr, x):
    first = -1
    last = -1
    for i in range(len(arr)):
        if (x != arr[i]):
            continue
        if (first == -1):
            first = i
        last = i
    return [first, last]
```

arr = $\begin{matrix} 1 & 2 & 3 & 4 & 5 \\ \downarrow & \downarrow & \downarrow & \downarrow & \downarrow \\ x = 5 & \cdots & \uparrow \end{matrix}$
 $\text{first} = 1 = 2$
 $\text{last} = 5 = 5$

return = $[2, 5]$

$O(n)$

$x=5$



1, 3, 5, 5, 5, 5, 7, 12

↓

① First
 low high
 ② loop $\text{high} \geq \text{low}$
 ③ $\text{mid} = \frac{\text{low} + \text{high}}{2}$
 ④ $x > \text{arr}[\text{mid}-1]$
 $\text{arr}[\text{mid}] \geq x$
 $\text{mid} \geq 0$

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

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

① Last
 low high
 ② loop $\text{high} \geq \text{low}$
 ③ $\text{mid} = \frac{\text{low} + \text{high}}{2}$
 ④ $x == \text{arr}[\text{mid}]$
 $\text{arr}[\text{mid}+1] > x$
 $\text{mid} = n-1$

if $x < \text{arr}[\text{mid}]$
~~high = mid - 1~~
 else $\text{low} = \text{mid} + 1$


```
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
```

