

SELECTION



The problem is to **find the kth smallest element**.

Complexity worst case is $T(n) = O(n^2)$ by repeated application of partition and the complexity is average case $T(n) = O(n)$.

Using median of medians as pivot complexity is $T(n) = O(n^2)$.

**COMPLEXITY
WORST CASE
PIVOT IS ARBITRARY
 $T(n) = O(n^2)$**

**COMPLEXITY
AVERAGE CASE
 $T(n) = O(n)$**

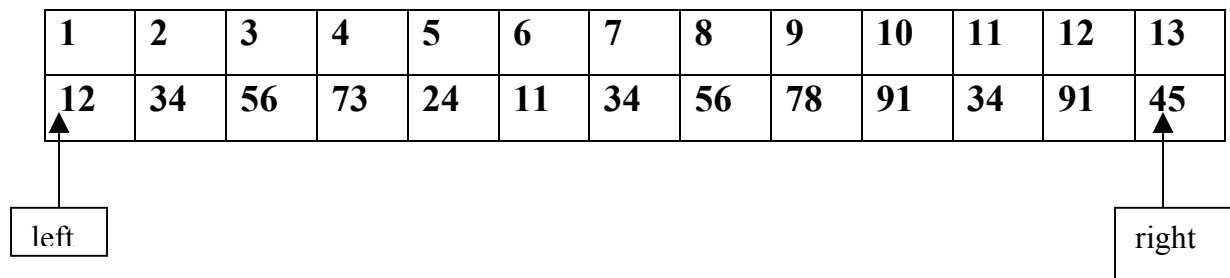
**COMPLEXITY
WORST CASE
PIVOT IS MEDIAN OF
MEDIAN
 $T(n) = O(n)$**

PROBLEM FOR SIMULATION

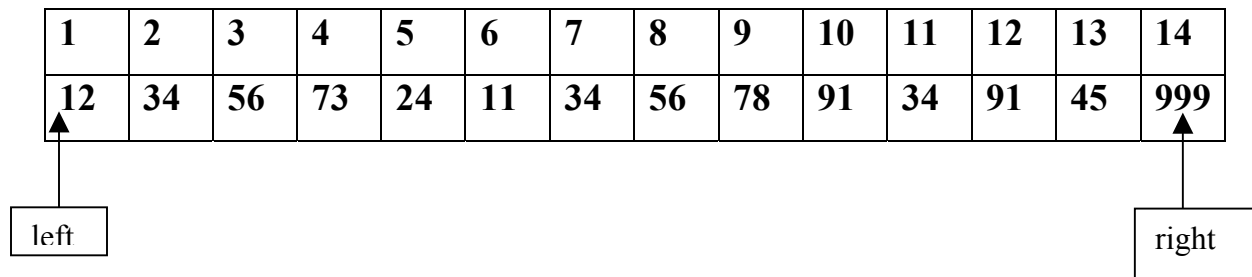
Consider the set {12,34,56,73,24,11,34,56,78,91,34,91,45}

FIND THE 5TH SMALLEST ELEMENT

INITIAL



KEEP A VERY LARGE ELEMENT AT THE RIGHT END



CALL PARTITION

The pointer “left” moves to the right skipping over smaller elements and the pointer “right” moves to the left skipping over larger elements.

MOVE

1	2	3	4	5	6	7	8	9	10	11	12	13	14
12	34	56	73	24	11	34	56	78	91	34	91	45	999

Diagram illustrating the initial state of an array during a partitioning step. The array contains 14 elements: 12, 34, 56, 73, 24, 11, 34, 56, 78, 91, 34, 91, 45, 999. The pivot element is 11, located at index 6. The pointer 'left' is positioned at index 2 (value 34), and the pointer 'right' is positioned at index 6 (value 11).

SWAP

1	2	3	4	5	6	7	8	9	10	11	12	13	14
12	11	56	73	24	34	34	56	78	91	34	91	45	999

Diagram illustrating the state of the array after a swap operation. The array contains 14 elements: 12, 11, 56, 73, 24, 34, 34, 56, 78, 91, 34, 91, 45, 999. The pointer 'left' is positioned at index 2 (value 11), and the pointer 'right' is positioned at index 6 (value 34).

MOVE

1	2	3	4	5	6	7	8	9	10	11	12	13	14
12	11	56	73	24	34	34	56	78	91	34	91	45	999

A diagram below the table shows two boxes: 'right' on the left and 'left' on the right. An arrow points from the 'right' box to the element '11' at index 2. Another arrow points from the 'left' box to the element '56' at index 3.

POSITION FOR PIVOT ELEMENT 12 IS 2 i.e. 2 IS THE 2ND SMALLEST ELEMENT

1	2	3	4	5	6	7	8	9	10	11	12	13	14
11	12	56	73	24	34	34	56	78	91	34	91	45	999

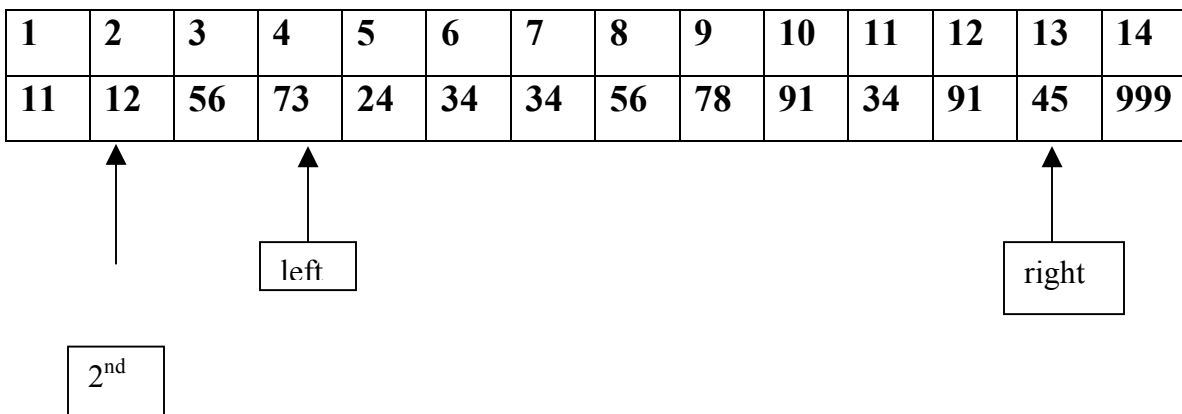
A diagram below the table shows three boxes: 'left' at index 3, 'right' at index 14, and '2nd' at index 2. An arrow points from the 'left' box to the element '56' at index 3. Another arrow points from the 'right' box to the element '999' at index 14. A third arrow points from the '2nd' box to the element '12' at index 2.

SEARCHING TO THE RIGHT OF 2ND ELEMENT

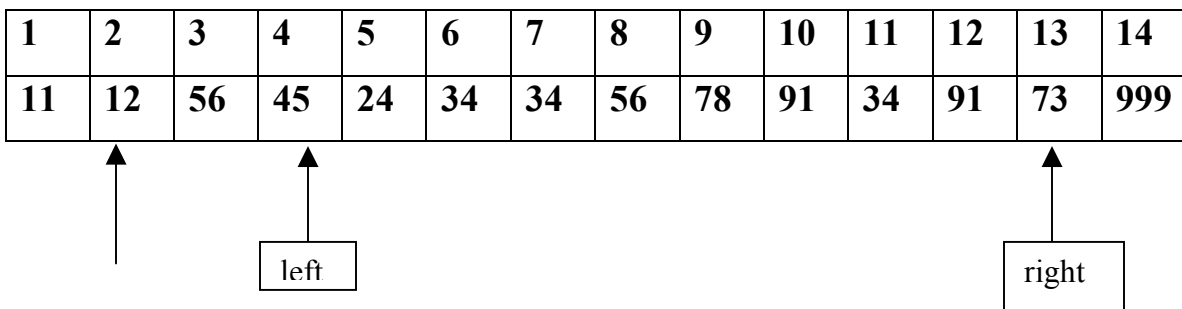
CALL PARTITION

The pointer “left” moves to the right skipping over smaller elements and the pointer “right” moves to the left skipping over larger elements.

MOVE



SWAP



2nd

MOVE

1	2	3	4	5	6	7	8	9	10	11	12	13	14
11	12	56	45	24	34	34	56	78	91	34	91	73	999

↑

left

right

2nd

SWAP

1	2	3	4	5	6	7	8	9	10	11	12	13	14
11	12	56	45	24	34	34	34	78	91	56	91	73	999

↑

left

right

2nd

MOVE

1	2	3	4	5	6	7	8	9	10	11	12	13	14
11	12	56	45	24	34	34	34	78	91	56	91	73	999

Diagram illustrating the movement of pointers and the pivot element:

- A box labeled "2nd" has an arrow pointing to the element 12 at index 2.
- A box labeled "right" has an arrow pointing to the element 34 at index 8.
- A box labeled "left" has an arrow pointing to the element 78 at index 9.

POSITION FOR PIVOT ELEMENT HAS BEEN FOUND AS THE POINTERS HAVE CROSSED. THE 8TH SMALLEST ELEMENT IS 56.

SWAP RIGHT WITH PIVOT

1	2	3	4	5	6	7	8	9	10	11	12	13	14
11	12	34	45	24	34	34	56	78	91	56	91	73	999

Diagram illustrating the swap of the pivot element with the element at the crossing point:

- A box labeled "2nd" has an arrow pointing to the element 12 at index 2.
- A box labeled "right" has an arrow pointing to the element 56 at index 8.
- A box labeled "left" has an arrow pointing to the element 78 at index 9.

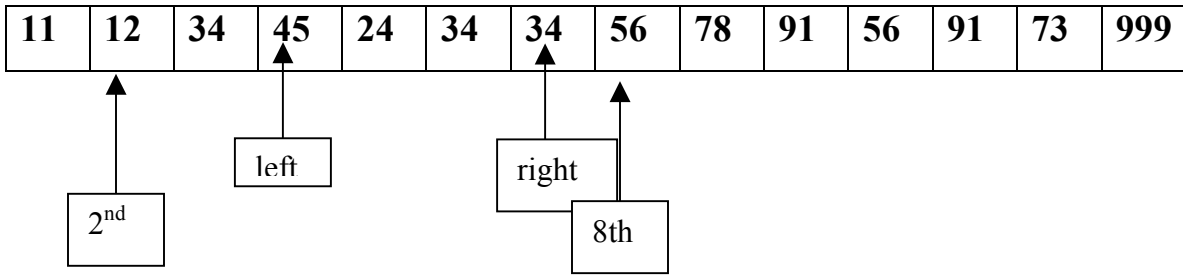
1	2	3	4	5	6	7	8	9	10	11	12	13	14
11	12	34	45	24	34	34	56	78	91	56	91	73	999

2nd
8th

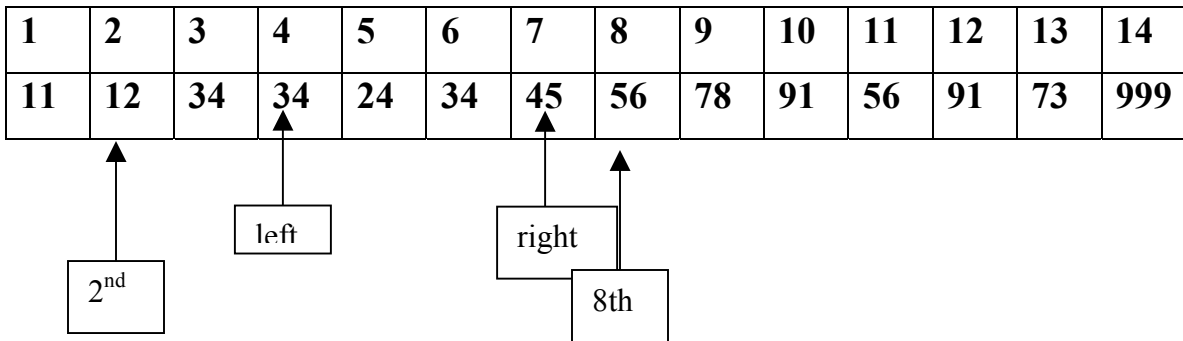
SEARCH BETWEEN 3 AND 7

1	2	3	4	5	6	7	8	9	10	11	12	13	14
11	12	34	45	24	34	34	56	78	91	56	91	73	999

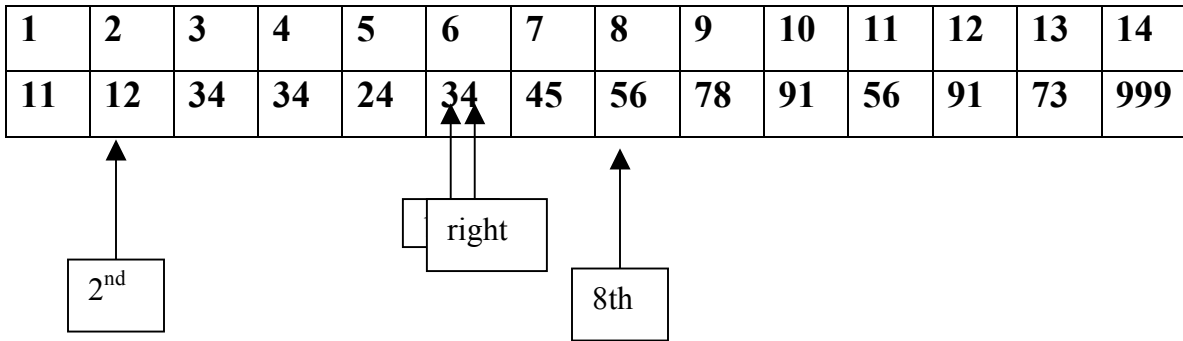
2nd
left
right
8th



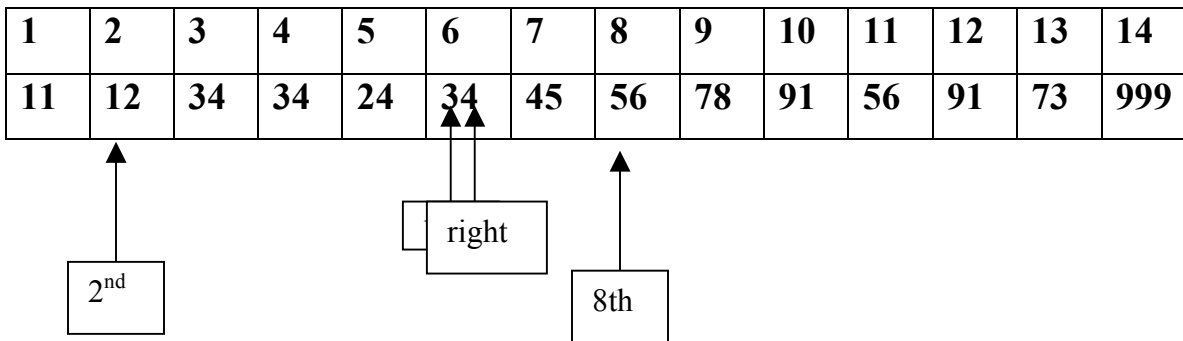
SWAP



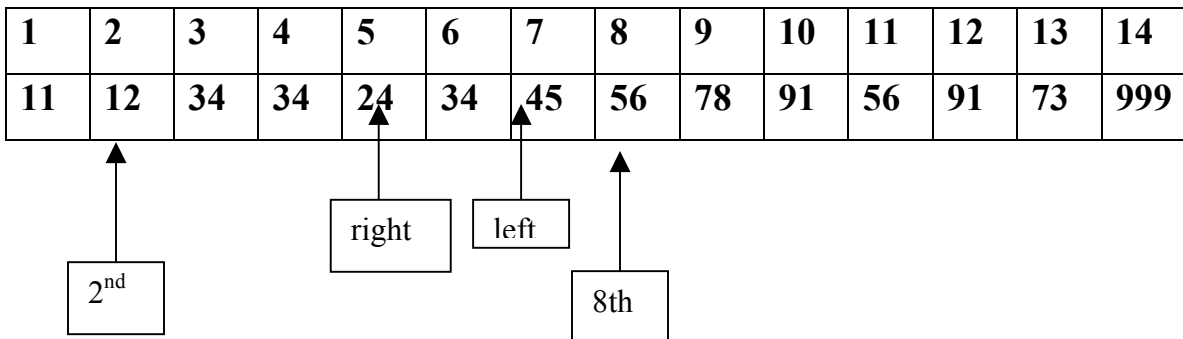
MOVE



SWAP



MOVE



POINTERS HAVE CROSSED SO 5 IS THE POSITION OF THE PIVOT ELEMENT 34.

1	2	3	4	5	6	7	8	9	10	11	12	13	14
11	12	24	34	34	34	45	56	78	91	56	91	73	999

The diagram illustrates the state of pointers during a partitioning process. It shows an array of 14 elements. The pivot element is 34, located at index 5. Three pointers are shown below the array, each in a box with an arrow pointing to a specific element: the first '2nd' pointer points to the element 12 at index 2; the second '2nd' pointer points to the pivot element 34 at index 5; and the '8th' pointer points to the element 56 at index 8.

POINTERS HAVE CROSSED SO 5 IS THE POSITION OF THE PIVOT ELEMENT 34.