DATA STRUCTURES

By

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RESOURCES

- http://javatpoint.com/

OUTLINE

- Logarithmic Sorting Algorithms

LOGARITHMIC SORTING ALGORITHMS

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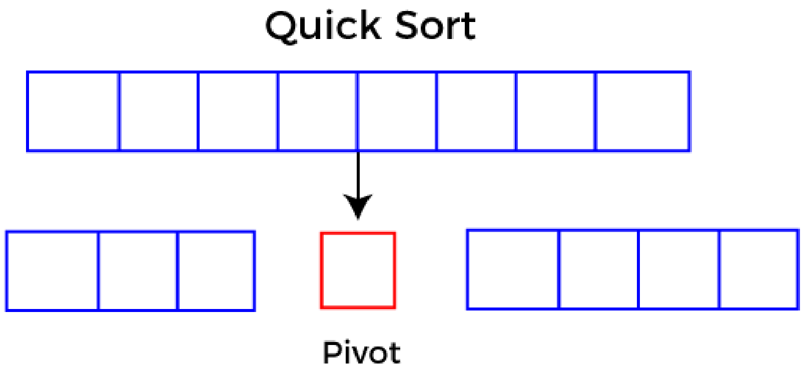
LOGARITHMIC SORTING ALGORITHMS

- Divide and conquer
  - Divide problem into smaller parts
  - Independently solve the parts
  - Combine these solutions to get overall solution

QUICKSORT

- **Algorithm**
  - Given a list of n elements
  - if the list have only one element
    - terminate.
  - Otherwise,
    - Randomly select one element and use it as a pivot.
    - Partition the rest of elements into two sub-lists
      - List of elements less than pivot.
      - List of elements greater than pivot.
    - Apply the same algorithm for the two sub-lists.



QUICKSORT ALGORITHM

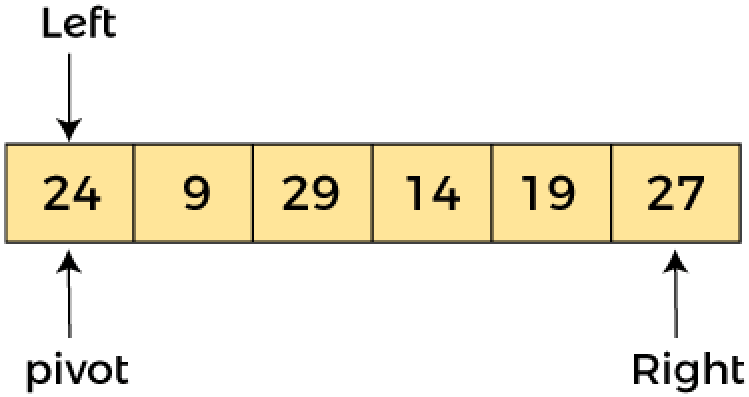
- Let’s have the following list a[]
- and we want to sort it using quicksort algorithm

24	9	29	14	19	27

- We use three pointers (indexes),
  - one for the leftmost element a[left]
  - one for the rightmost element a[right]
  - one for the pivot a[pivot]
- Pivot element is selected randomly, let it be the first element.

QUICKSORT ALGORITHM

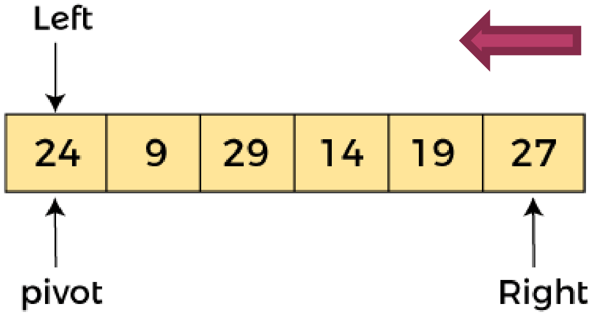
- So, the initial state is as follows:



- The idea is to partition the elements of the list so that the pivot is placed in an index where:
  - All the elements at the left are less than the pivot element
  - All the elements at the right are greater than the pivot element

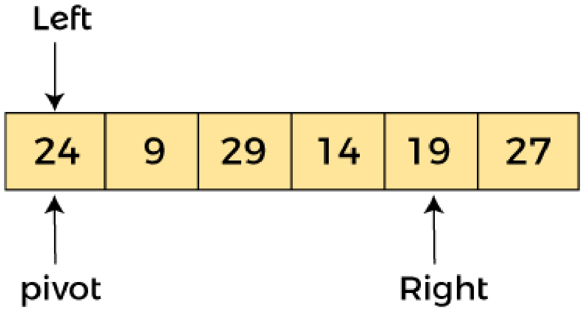
PARTITION

- The current state is
  - a[left] = 24,
  - a[right] = 27 and
  - a[pivot] = 24



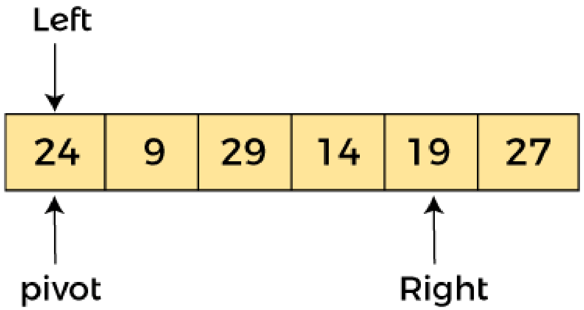
  - Now, pivot is at left, so algorithm starts from right and **move towards left**.

  - Since a[pivot] < a[right], we keep the a[right] element as it is and move the right pointer one position towards left



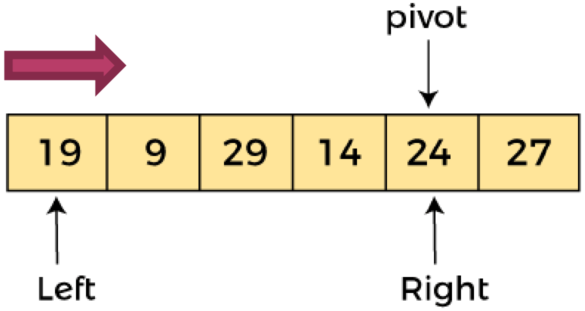
PARTITION

- Since, a[pivot] > a[right], so, algorithm will swap a[pivot] with a[right], and pivot moves to right.



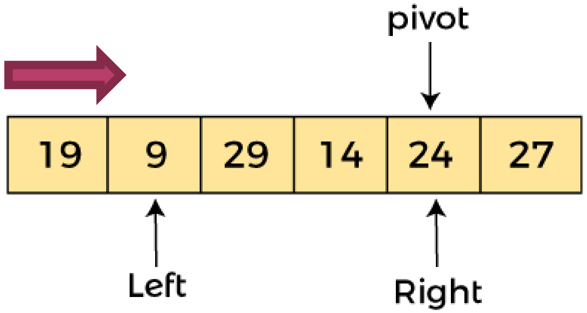
24	9	29	14	19	27

- Since, pivot is at right, so algorithm starts from left and moves to right.



19	9	29	14	24	27

- Now, a[pivot] > a[left], so we keep a[left] as it is and move the left pointer to the right.



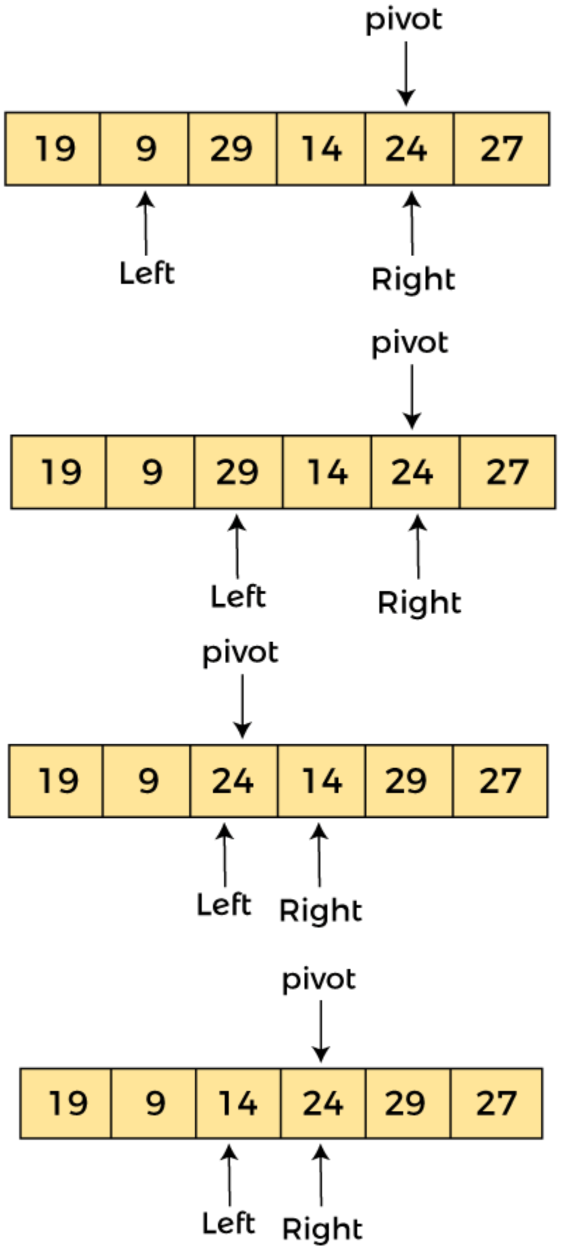
19	9	29	14	24	27

PARTITION

- As a[pivot] > a[left], so algorithm **moves one position to right**.

- Now, as a[pivot] < a[left], so, we **swap a[pivot] and a[left]**, now pivot is at left.

- Now, as a[pivot] > a[right], so, we swap a[pivot] and a[right], now pivot is at right



19	9	29	14	24	27

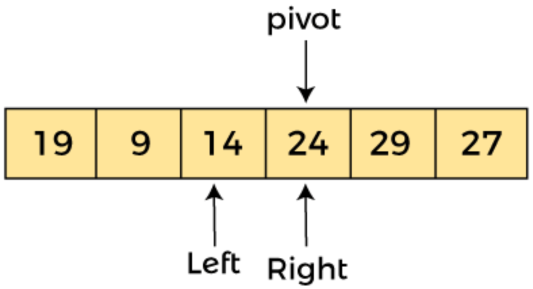
19	9	29	14	24	27

19	9	24	14	29	27

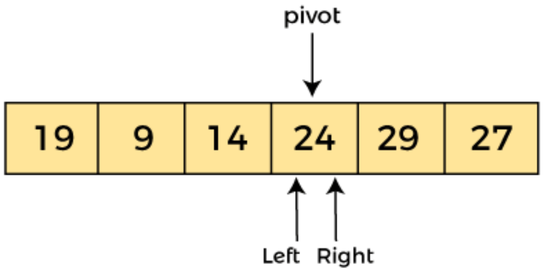
19	9	14	24	29	27

PARTITION

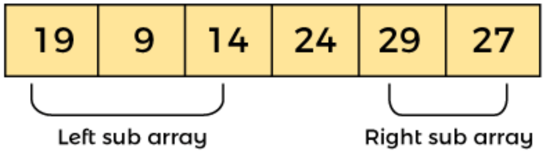
- Now, pivot is at right, so the algorithm moves left pointer towards right.



- Finally, pivot, left and right are pointing the same element. It represents the termination

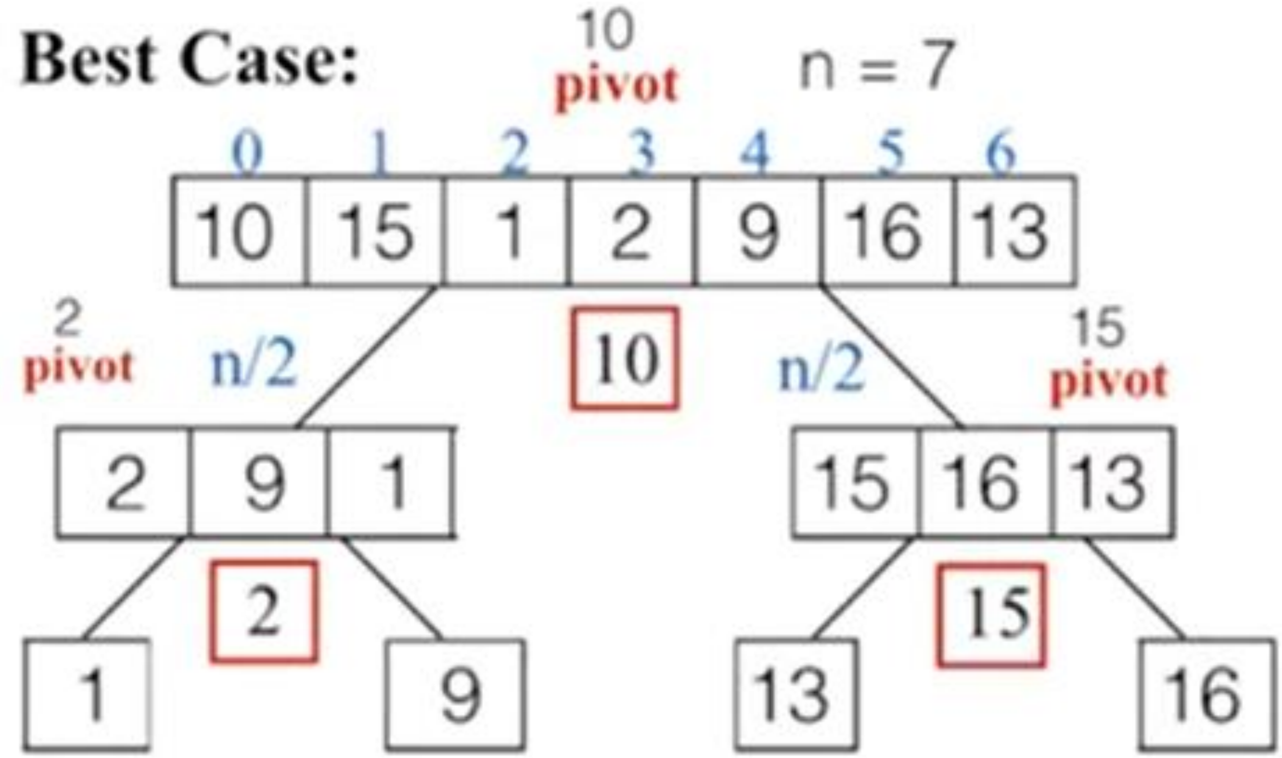


- Now, we can say that the pivot element divides the original list into two sub-lists (partitions) where all elements of the left sub-list are less than pivot and all elements of the right sub-list are greater than pivot.



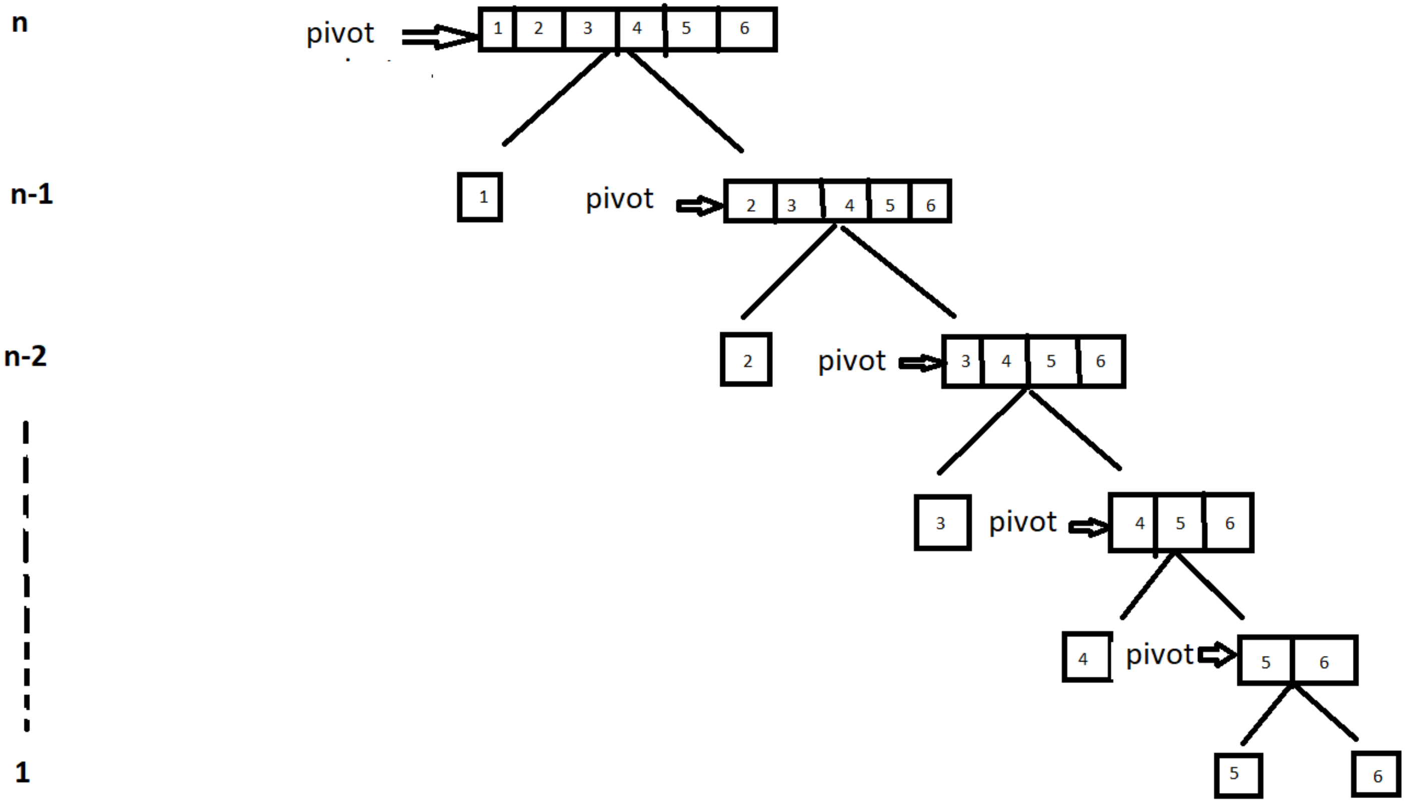
QUICKSORT BEST CASE

```
QUICKSORT (array A, start, end)
{
        if (start < end)
        {
                p = partition(A, start, end)
                QUICKSORT (A, start, p - 1)
                QUICKSORT (A, p + 1, end)
        }
}
```



QUICKSORT WORST CASE

```
QUICKSORT (array A, start, end)
{
        if (start < end)
        {
                p = partition(A, start, end)
                QUICKSORT (A, start, p - 1)
                QUICKSORT (A, p + 1, end)
        }
}
```



ASSIGNMENT

- Prove that Quicksort worst case is $O(n^2)$.
- Prove that Quicksort best case and average case is $O(n\log_2 n)$.

THANK YOU

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