Experiment No. 3
Quick Sort
Date of Performance:
Date of Submission:

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Title: Quick Sort

Aim: To implement Quick Sort and Comparative analysis for large values of 'n'.

Objective: To introduce the methods of designing and analyzing algorithms.

Theory:

The merge sort algorithm closely follows the divide-and-conquer paradigm. Intuitively, it operates as follows:

1. Divide: Divide the n-element sequence to be sorted into two subsequences of n=2 elements each.
2. Conquer: Sort the two subsequences recursively using merge sort.
3. Combine: Merge the two sorted subsequence to produce the sorted answer.

Partition-exchange sort or quicksort algorithm was developed in 1960 by Tony Hoare. He developed the algorithm to sort the words to be translated, to make them more easily matched to an already-sorted Russian-to-English dictionary that was stored on magnetic tape.

Quick sort algorithm on average, makes O(n log n) comparisons to sort n items. In the worst case, it makes O(n2) comparisons, though this behavior is rare. Quicksort is often faster in practice than other O(n log n) algorithms. Additionally, quicksort's sequential and localized memory references work well with a cache. Quicksort is a comparison sort and, in efficient implementations, is not a stable sort. Quicksort can be implemented with an in-place partitioning algorithm, so the entire sort can be done with only O(log n) additional space used by the stack during the recursion.

Quicksort is a divide and conquer algorithm. Quicksort first divides a large list into two smaller sub-lists: the low elements and the high elements. Quicksort can then recursively sort the sublists.

1. Elements less than pivot element.

2. Pivot element.

3. Elements greater than pivot element.

Where pivot as middle element of large list. Let's understand through example:

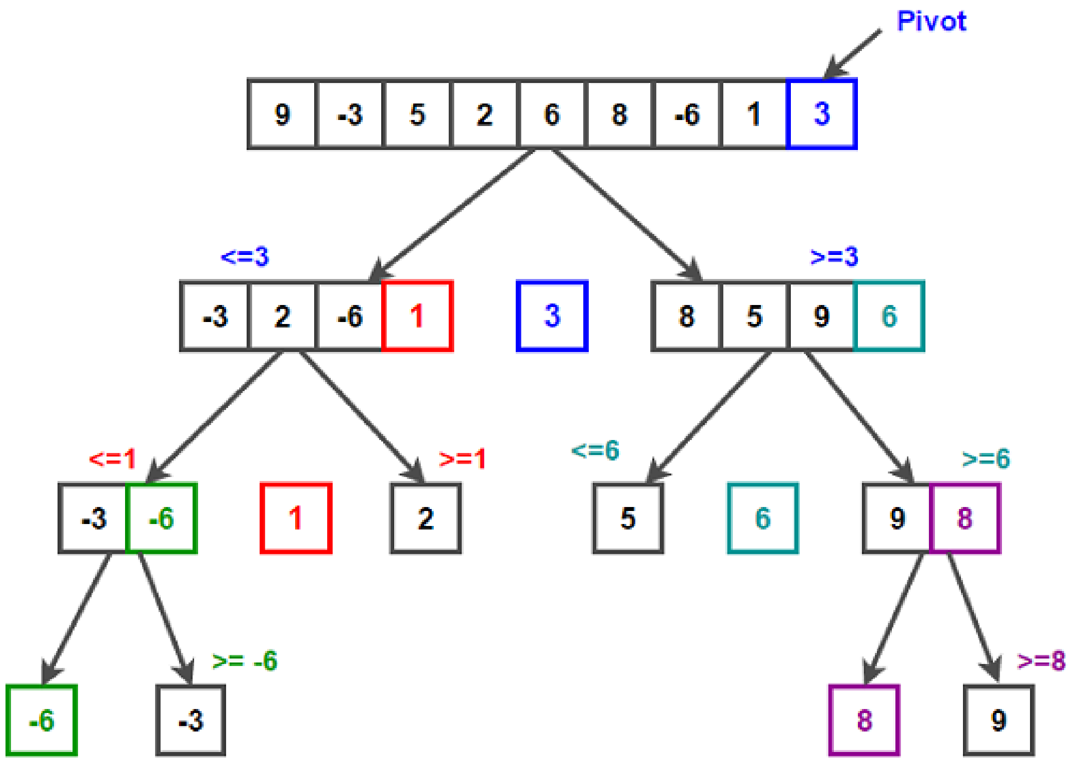
List : 3 7 8 5 2 1 9 5 4

In above list assume 4 is pivot element so rewrite list as:

3 1 2 4 5 8 9 5 7

Here, I want to say that we set the pivot element (4) which has in left side elements are less than and right hand side elements are greater than. Now you think, how's arrange the less than and greater than elements? Be patient, you get answer soon.

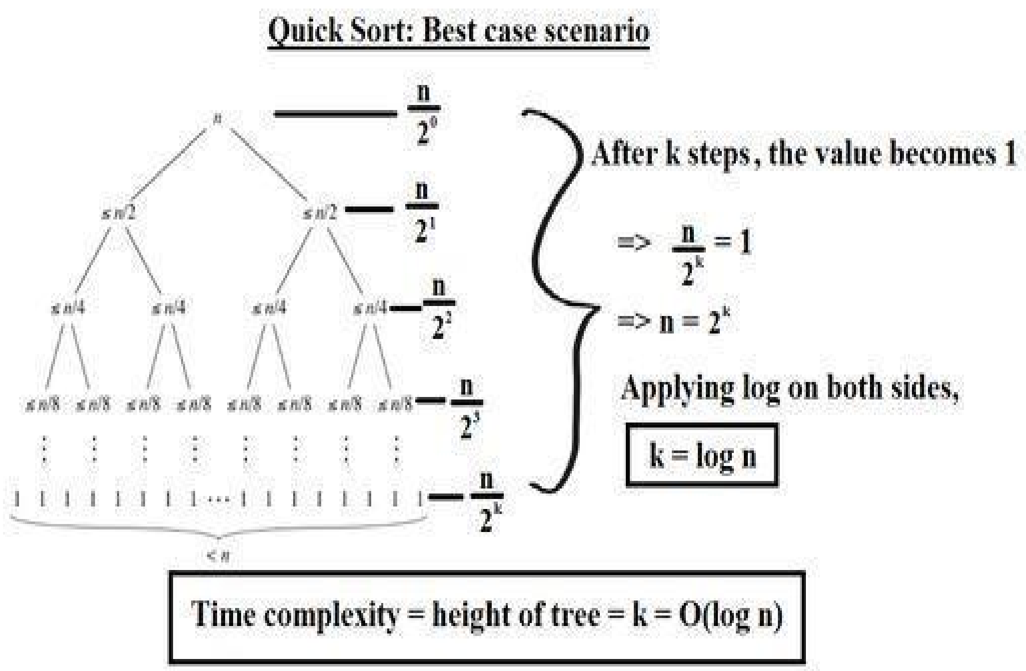
Example:

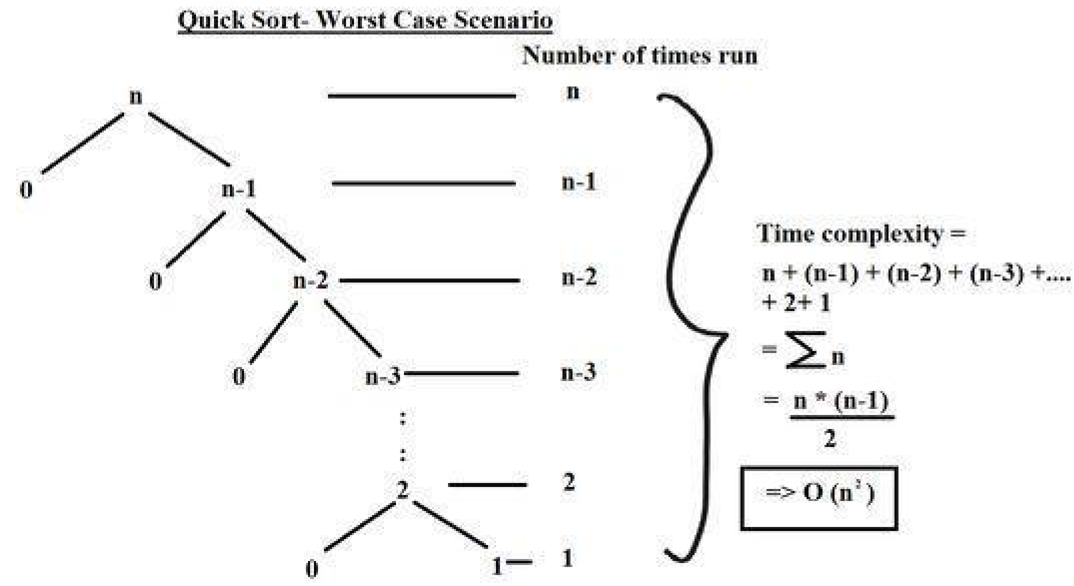



```
/* low  --> Starting index,  high  --> Ending index */
quickSort(arr[], low, high)
{
    if (low < high)
    {
        /* pi is partitioning index, arr[pi] is now
           at right place */
        pi = partition(arr, low, high);
        quickSort(arr, low, pi - 1);  // Before pi
        quickSort(arr, pi + 1, high); // After pi
    }
}
/* This function takes last element as pivot, places
   the pivot element at its correct position in sorted
    array, and places all smaller (smaller than pivot)
   to left of pivot and all greater elements to right
   of pivot */
```

```
partition (arr[], low, high)
{
   // pivot (Element to be placed at right position)
   pivot = arr[high];

   i = (low - 1)  // Index of smaller element and indicates the
                  // right position of pivot found so far
   for (j = low; j <= high- 1; j++)
   {
      // If current element is smaller than the pivot
      if (arr[j] < pivot)
      {
         i++;    // increment index of smaller element
         swap arr[i] and arr[j]
      }
   }
   swap arr[i + 1] and arr[high])
   return (i + 1)
}
```





Implementation:

```
#include <stdio.h>


// Function to partition the array and return the pivot index

int partition(int arr[], int low, int high) {

    int pivot = arr[high];

    int i = low - 1;


    for (int j = low; j < high; j++) {

        if (arr[j] <= pivot) {

            i++;

            // Swap arr[i] and arr[j]

            int temp = arr[i];

            arr[i] = arr[j];
```

```
            arr[j] = temp;
        }
    }

    // Swap arr[i+1] and arr[high] (pivot)
    int temp = arr[i + 1];
    arr[i + 1] = arr[high];
    arr[high] = temp;

    return i + 1;
}

// Function to perform QuickSort on the array
void quickSort(int arr[], int low, int high) {
    if (low < high) {
        // Partition the array and get the pivot index
        int pivotIndex = partition(arr, low, high);

        // Recursively sort the subarrays
        quickSort(arr, low, pivotIndex - 1);
        quickSort(arr, pivotIndex + 1, high);
    }
}
```

```
// Function to print an array
void printArray(int arr[], int size) {
    for (int i = 0; i < size; i++) {
        printf("%d ", arr[i]);
    }
    printf("\n");
}

// Example usage
int main() {
    int arr[] = {12, 5, 7, 3, 2, 8, 4};
    int size = sizeof(arr) / sizeof(arr[0]);

    printf("Original array: ");
    printArray(arr, size);

    quickSort(arr, 0, size - 1);

    printf("Sorted array: ");
    printArray(arr, size);

    return 0;
```

```
}
```

Conclusion: Quick Sort algorithm has been successfully implemented.