PROGRAM 1

Sort a given set of N integer elements using Merge Sort technique and compute its time taken. Run the program for different values of N and record the time taken to sort.

ALGORITHM:

```
void merge (int arr[], int left, int mid, int right) {
    int n1 = mid - left + 1;
    int n2 = right - mid;
    int L[n1], R[n2];
    for (int i=0; i<n1; i++)
        L[i] = arr[left + i];
    for (int j=0; j<n2; j++)
        R[j] = arr[mid + 1 + j];
    int i=0, j=0, k=left;
    while (i<n1 && j<n2) {
        if (L[i] <= R[j]) {
            arr[k] = L[i];
            i++;
        } else {
            arr[k] = R[j];
            j++;
        }
        k++;
    }
```

```
    while (i<n1) {
        arr[k] = L[i];
        i++;
        k++;
    }
    while (j<n2) {
        arr[k] = R[j];
        j++;
        k++;
    }
}
void mergeSort (int arr[], int left, int right) {
    if (left < right) {
        int mid = left + (right - left) / 2;
        mergeSort (arr, left, mid);
        mergeSort (arr, mid+1, right);
        merge (arr, left, mid, right);
```

CODE:

```
#include <stdio.h>
#include <stdlib.h>
#include <time.h>

// Function to merge two halves
void merge(int arr[], int left, int mid, int right) {
    int i, j, k;
    int n1 = mid - left + 1;
    int n2 = right - mid;

    // Temporary arrays
    int L[n1], R[n2];

    // Copy data
    for (i = 0; i < n1; i++)
        L[i] = arr[left + i];
    for (j = 0; j < n2; j++)
        R[j] = arr[mid + 1 + j];

    // Merge the temp arrays
    i = 0;
    j = 0;
    k = left;
    while (i < n1 && j < n2) {
        if (L[i] <= R[j]) {
            arr[k++] = L[i++];
        } else {
            arr[k++] = R[j++];
        }
    }
```

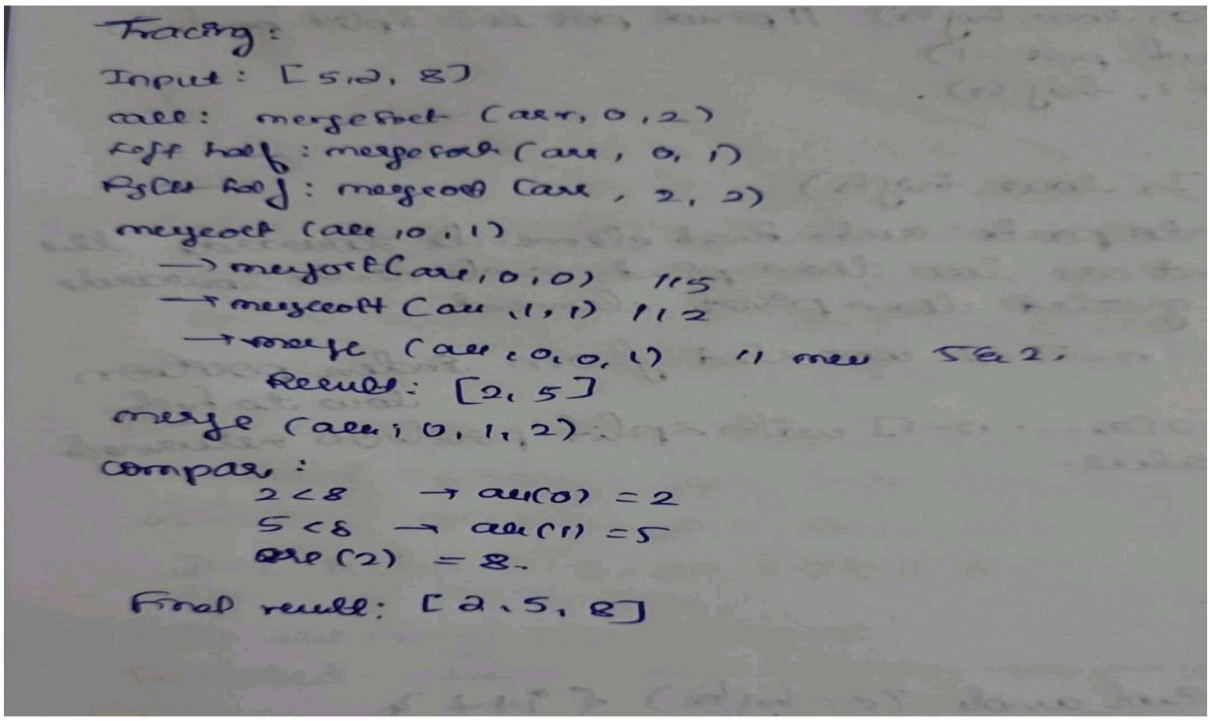
```
    // Copy remaining elements
    while (i < n1) {
        arr[k++] = L[i++];
    }
    while (j < n2) {
        arr[k++] = R[j++];
    }
}

// Merge Sort function
void mergeSort(int arr[], int left, int right) {
    if (left < right) {
        int mid = (left + right) / 2;

        mergeSort(arr, left, mid);        // Left half
        mergeSort(arr, mid + 1, right);   // Right half

        merge(arr, left, mid, right);     // Merge halves
    }
}

int main() {
    int N, i;
    printf("Enter the number of elements (N): ");
    scanf("%d", &N);

    int arr[N];
    printf("Enter %d integer elements:\n", N);
    for (i = 0; i < N; i++) {
```

```
        scanf("%d", &arr[i]);
    }

    clock_t start, end;
    double time_taken;

    start = clock();
    mergeSort(arr, 0, N - 1);
    end = clock();

    time_taken = ((double)(end - start)) / CLOCKS_PER_SEC;

    printf("Sorted array:\n");
    for (i = 0; i < N; i++) {
        printf("%d ", arr[i]);
    }

    printf("\nTime taken to sort %d elements: %f seconds\n", N, time_taken);

    return 0;
}
```

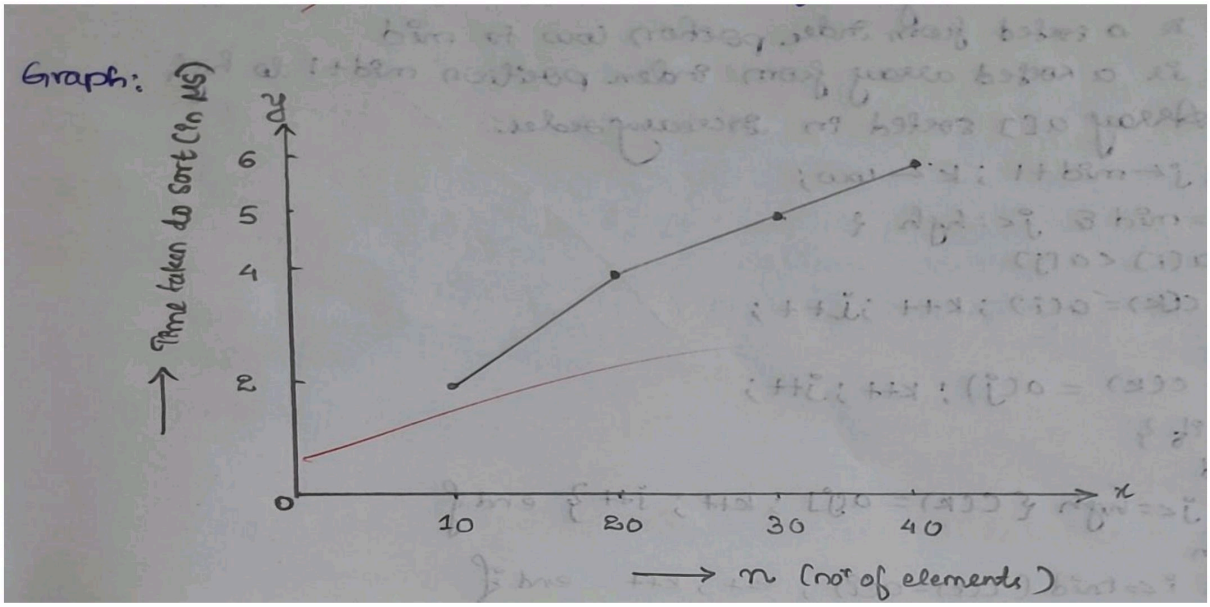
OUTPUT:

```
Enter the number of elements (N): 5
Enter 5 integer elements:
1 2 3 4 5
Sorted array:
1 2 3 4 5
Time taken to sort 5 elements: 0.000002 seconds
```

TRACING:



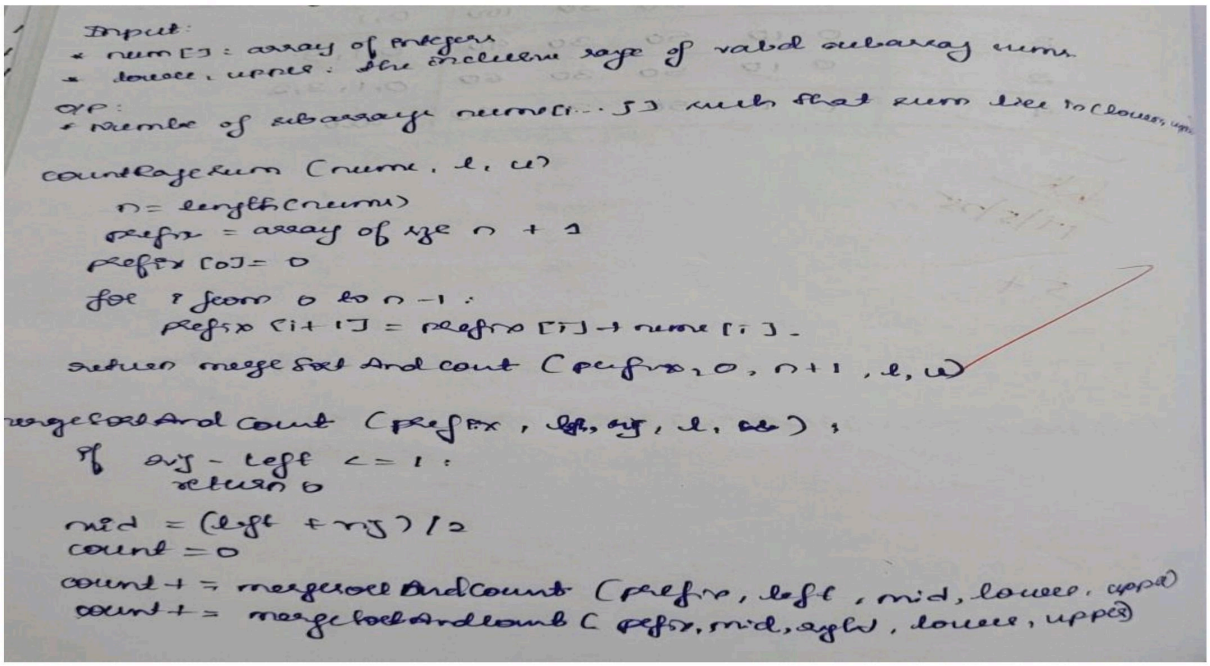
GRAPH:

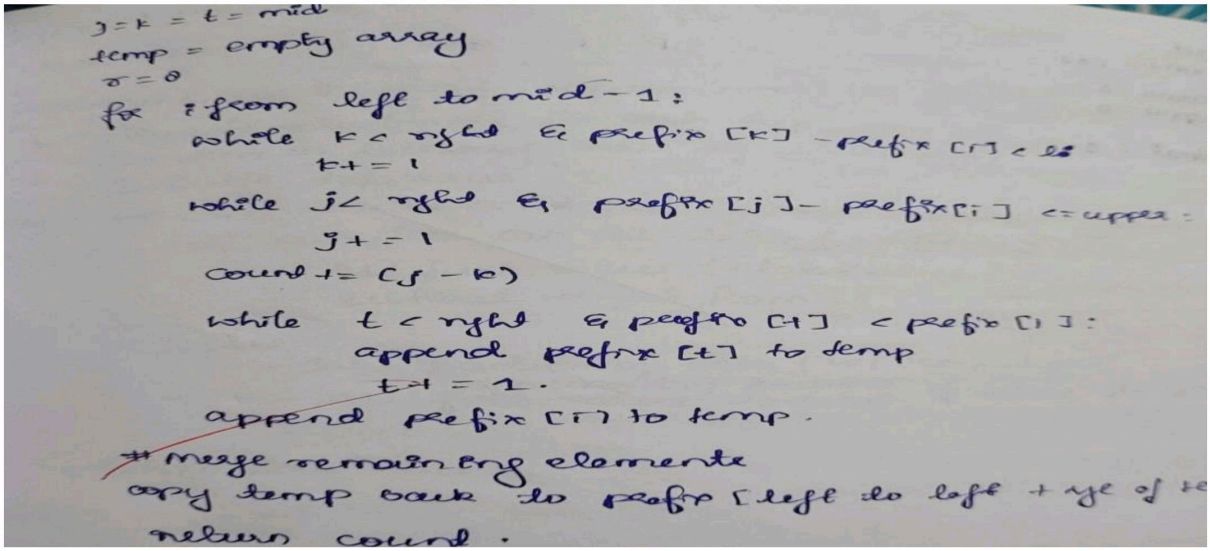


LEETCODE 1

COUNT RANGE SUM

ALGORITHM





CODE:

```
#include <stdio.h>
#include <stdlib.h>

int countWhileMergeSort(long* sum, int left, int right, int lower, int upper) {
    if (right - left <= 1) return 0;

    int mid = (left + right) / 2;
    int count = countWhileMergeSort(sum, left, mid, lower, upper) +
                countWhileMergeSort(sum, mid, right, lower, upper);

    int j = mid, k = mid, t = mid, r = 0;
    long* cache = (long*)malloc((right - left) * sizeof(long));

    for (int i = left; i < mid; ++i) {
        while (k < right && sum[k] - sum[i] < lower) k++;
        while (j < right && sum[j] - sum[i] <= upper) j++;
        count += j - k;

        while (t < right && sum[t] < sum[i])
            cache[r++] = sum[t++];
        cache[r++] = sum[i];
    }

    for (int i = 0; i < t - left; ++i)
        sum[left + i] = cache[i];

    free(cache);
    return count;
}
```

```
int countRangeSum(int* nums, int numsSize, int lower, int upper) {
    long* prefix = (long*)malloc((numsSize + 1) * sizeof(long));
    prefix[0] = 0;
    for (int i = 0; i < numsSize; i++) {
        prefix[i + 1] = prefix[i] + nums[i];
    }

    int result = countWhileMergeSort(prefix, 0, numsSize + 1, lower, upper);
    free(prefix);
    return result;
}

int main() {
    int nums[] = {-2, 5, -1};
    int size = sizeof(nums) / sizeof(nums[0]);
    int lower = -2, upper = 2;

    int result = countRangeSum(nums, size, lower, upper);
    printf("Count of Range Sum in [%d, %d] is: %d\n", lower, upper, result);

    return 0;
}
```

OUTPUT:

Accepted Runtime: 0 ms

• Case 1 • Case 2

Input

nums =
[0]

lower =
0

upper =
0

Output

1

Expected

1

Accepted Runtime: 0 ms

• Case 1 • Case 2

Input

nums =
[-2,5,-1]

lower =
-2

upper =
2

Output

3

Expected

3

TRACING: