MERGE SORT PERFORMANCE ANALYSIS REPORT

Name – Aman Maggon

SAP ID – 590015673

Batch - 34

Course – Design Analysis Algorithm

Git hub repository link:

https://github.com/AmanMaggon/DAALAB_-AmanMaggon-_590015673

1. Merge Sort Algorithm

Merge Sort is a sorting technique that uses the divide and conquer method.

- **Divide**: Break the array into two smaller halves.
- **Conquer**: Sort each half separately using recursion.
- **Combine**: Merge the two sorted halves into one sorted array.

Time Complexity For Merge Sort

- Best Case → O(n log n)
- Average Case → O(n log n)
- Worst Case → O(n log n)

---

2. C Source Code

INPUT-

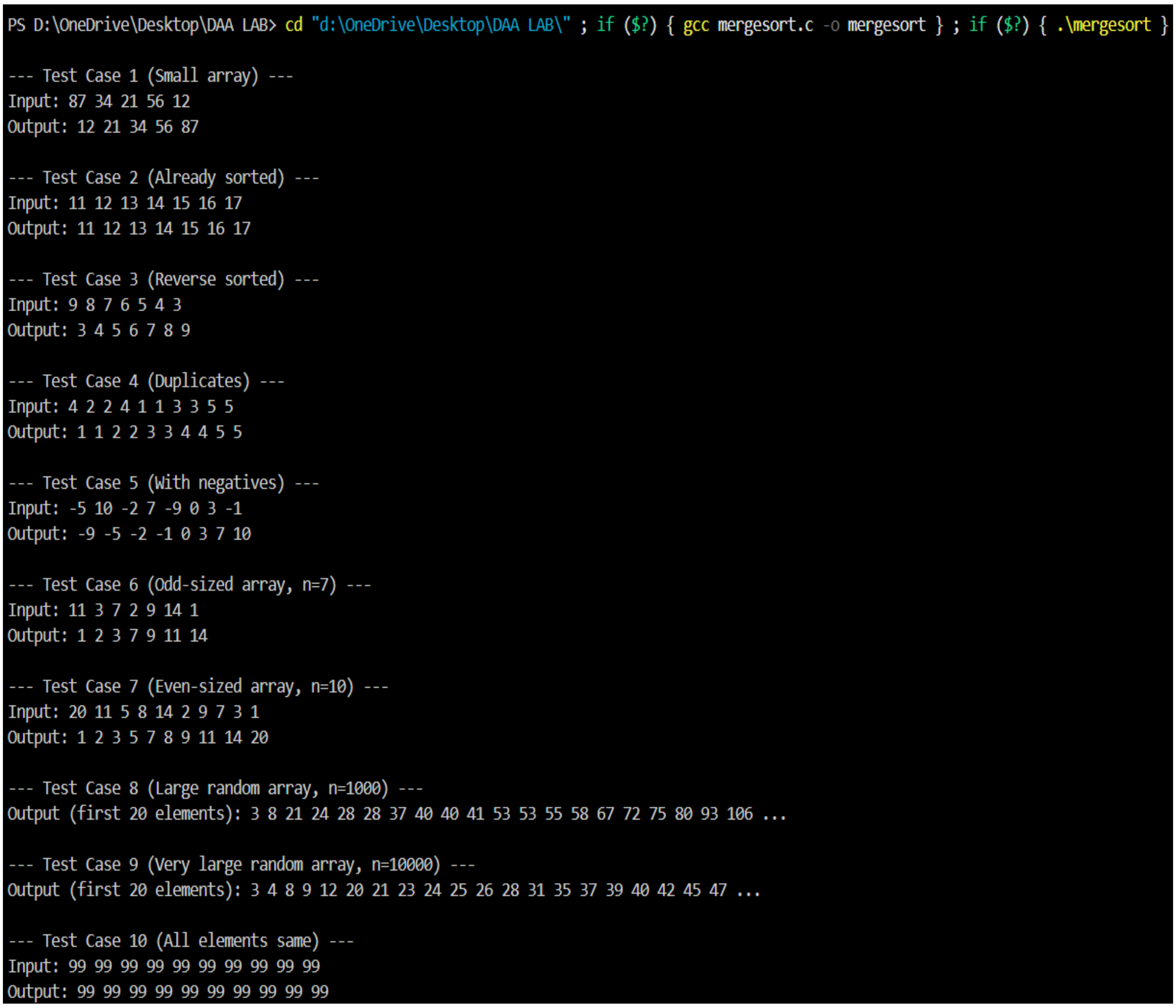
```
#include <stdio.h>
#include <stdio.h>
#include <stdlib.h>

void merge(int arr[], int low, int mid, int high)
{
   int n1 = (mid - low) + 1;
   int n2 = (high - mid);
   int Left[n1];
   int Right[n2];
   for (int i = 0; i < n1; i++)
   {
      Left[i] = arr[low + i];
   }
   for (int j = 0; j < n2; j++)
   {
      Right[j] = arr[mid + 1 + j];
   }
```

```
    int left = 0, right = 0, k = low;
    while (left < n1 && right < n2)
    {
        if (Left[left] < Right[right])
        {
            arr[k] = Left[left];
            left++;
            k++;
        }
        else
        {
            arr[k] = Right[right];
            right++;
            k++;
        }
    }
    while (left < n1)
    {
        arr[k++] = Left[left++];
    }
    while (right < n2)
    {
        arr[k++] = Right[right++];
    }
}

void merge_sort(int arr[], int low, int high)
{
    if (low >= high)
    {
        return;
    }
    else
    {
        int mid = (high - low) / 2 + low;
        merge_sort(arr, low, mid);
        merge_sort(arr, mid + 1, high);
        merge(arr, low, mid, high);
    }
}

void printArray(int arr[], int n)
{
    for (int i = 0; i < n; i++)
    {
        printf("%d ", arr[i]);
    }
    printf("\n");
}

int main()
{
    // Test Case 1 - Small Array
    {
        int arr[] = {87, 34, 21, 56, 12};
        int n = sizeof(arr) / sizeof(arr[0]);
        printf("\n--- Test Case 1 (Small array) ---\n");
        printf("Input: ");
        printArray(arr, n);
        merge_sort(arr, 0, n - 1);
        printf("Output: ");
        printArray(arr, n);
    }
```

```
// Test Case 2 - Already Sorted Array
{
    int arr[] = {11, 12, 13, 14, 15, 16, 17};
    int n = sizeof(arr) / sizeof(arr[0]);
    printf("\n--- Test Case 2 (Already sorted) ---\n");
    printf("Input: ");
    printArray(arr, n);
    merge_sort(arr, 0, n - 1);
    printf("Output: ");
    printArray(arr, n);
}

// Test Case 3 – Reverse sorted array
{
    int arr[] = {9, 8, 7, 6, 5, 4, 3};
    int n = sizeof(arr) / sizeof(arr[0]);
    printf("\n--- Test Case 3 (Reverse sorted) ---\n");
    printf("Input: ");
    printArray(arr, n);
    merge_sort(arr, 0, n - 1);
    printf("Output: ");
    printArray(arr, n);
}

// Test Case 4 – Array with duplicates
{
    int arr[] = {4, 2, 2, 4, 1, 1, 3, 3, 5, 5};
    int n = sizeof(arr) / sizeof(arr[0]);
    printf("\n--- Test Case 4 (Duplicates) ---\n");
    printf("Input: ");
    printArray(arr, n);
    merge_sort(arr, 0, n - 1);
    printf("Output: ");
    printArray(arr, n);
}

// Test Case 5 – Array with negative numbers
{
    int arr[] = {-5, 10, -2, 7, -9, 0, 3, -1};
    int n = sizeof(arr) / sizeof(arr[0]);
    printf("\n--- Test Case 5 (With negatives) ---\n");
    printf("Input: ");
    printArray(arr, n);
    merge_sort(arr, 0, n - 1);
    printf("Output: ");
    printArray(arr, n);
}

// Test Case 6 – Odd-sized array
{
    int arr[] = {11, 3, 7, 2, 9, 14, 1};
    int n = sizeof(arr) / sizeof(arr[0]);
    printf("\n--- Test Case 6 (Odd-sized array, n=7) ---\n");
    printf("Input: ");
    printArray(arr, n);
    merge_sort(arr, 0, n - 1);
    printf("Output: ");
    printArray(arr, n);
}

// Test Case 7 – Even-sized array
{
    int arr[] = {20, 11, 5, 8, 14, 2, 9, 7, 3, 1};
    int n = sizeof(arr) / sizeof(arr[0]);
    printf("\n--- Test Case 7 (Even-sized array, n=10) ---\n");
    printf("Input: ");
    printArray(arr, n);
    merge_sort(arr, 0, n - 1);
    printf("Output: ");
    printArray(arr, n);
}

// Test Case 8 – Large random array (n=1000)
{
    int n = 1000;
    int arr[n];
    for (int i = 0; i < n; i++)
    {
        arr[i] = rand() % 10000;
    }
    printf("\n--- Test Case 8 (Large random array, n=1000) ---\n");
    merge_sort(arr, 0, n - 1);
    printf("Output (first 20 elements): ");
    for (int i = 0; i < 20; i++)
        printf("%d ", arr[i]);
    printf("...\n");
}

// Test Case 9 – Very large random array (n=10000)
{
    int n = 10000;
    int arr[n];
    for (int i = 0; i < n; i++)
    {
        arr[i] = rand() % 100000;
    }
```

```
        printf("\n--- Test Case 9 (Very large random array, n=10000) ---\n");
        merge_sort(arr, 0, n - 1);
        printf("Output (first 20 elements): ");
        for (int i = 0; i < 20; i++)
            printf("%d ", arr[i]);
        printf("...\n");
    }

    // Test Case 10 – All elements same
    {
        int arr[] = {99, 99, 99, 99, 99, 99, 99, 99, 99, 99};
        int n = sizeof(arr) / sizeof(arr[0]);
        printf("\n--- Test Case 10 (All elements same) ---\n");
        printf("Input: ");
        printArray(arr, n);
        merge_sort(arr, 0, n - 1);
        printf("Output: ");
        printArray(arr, n);
    }

    return 0;
}
```

OUTPUT-



```
PS D:\OneDrive\Desktop\DAA LAB> cd "d:\OneDrive\Desktop\DAA LAB\" ; if ($?) { gcc mergesort.c -o mergesort } ; if ($?) { .\mergesort }

--- Test Case 1 (Small array) ---
Input: 87 34 21 56 12
Output: 12 21 34 56 87

--- Test Case 2 (Already sorted) ---
Input: 11 12 13 14 15 16 17
Output: 11 12 13 14 15 16 17

--- Test Case 3 (Reverse sorted) ---
Input: 9 8 7 6 5 4 3
Output: 3 4 5 6 7 8 9

--- Test Case 4 (Duplicates) ---
Input: 4 2 2 4 1 1 3 3 5 5
Output: 1 1 2 2 3 3 4 4 5 5

--- Test Case 5 (With negatives) ---
Input: -5 10 -2 7 -9 0 3 -1
Output: -9 -5 -2 -1 0 3 7 10

--- Test Case 6 (Odd-sized array, n=7) ---
Input: 11 3 7 2 9 14 1
Output: 1 2 3 7 9 11 14

--- Test Case 7 (Even-sized array, n=10) ---
Input: 20 11 5 8 14 2 9 7 3 1
Output: 1 2 3 5 7 8 9 11 14 20

--- Test Case 8 (Large random array, n=1000) ---
Output (first 20 elements): 3 8 21 24 28 28 37 40 40 41 53 53 55 58 67 72 75 80 93 106 ...

--- Test Case 9 (Very large random array, n=10000) ---
Output (first 20 elements): 3 4 8 9 12 20 21 23 24 25 26 28 31 35 37 39 40 42 45 47 ...

--- Test Case 10 (All elements same) ---
Input: 99 99 99 99 99 99 99 99 99 99
Output: 99 99 99 99 99 99 99 99 99 99
```

3. Test Case Descriptions

1. Already Sorted Array

- **Purpose:** To check if Merge Sort can handle an array that is already sorted without doing extra work.

2. Reverse Sorted Array

- **Purpose:** To test the case when the array is in descending order (worst case).

3. Array with Duplicates

- **Purpose:** To make sure Merge Sort works properly when some numbers are repeated.

4. Array with Negative Numbers

- **Purpose:** To confirm that the algorithm can also sort arrays containing negative values.

5. Single Element Array

- **Purpose:** Edge case to see if Merge Sort works when the array has only one element.

6. Empty Array

- **Purpose:** Edge case to ensure the algorithm does not crash when the input is empty.

7. Array with Both Negatives and Positives

- **Purpose:** To check how Merge Sort deals with a mix of negative and positive numbers.

8. Array with All Equal Elements

- **Purpose:** To verify that if all numbers are the same, the algorithm still runs correctly and keeps stability.

9. Array with Large Numbers

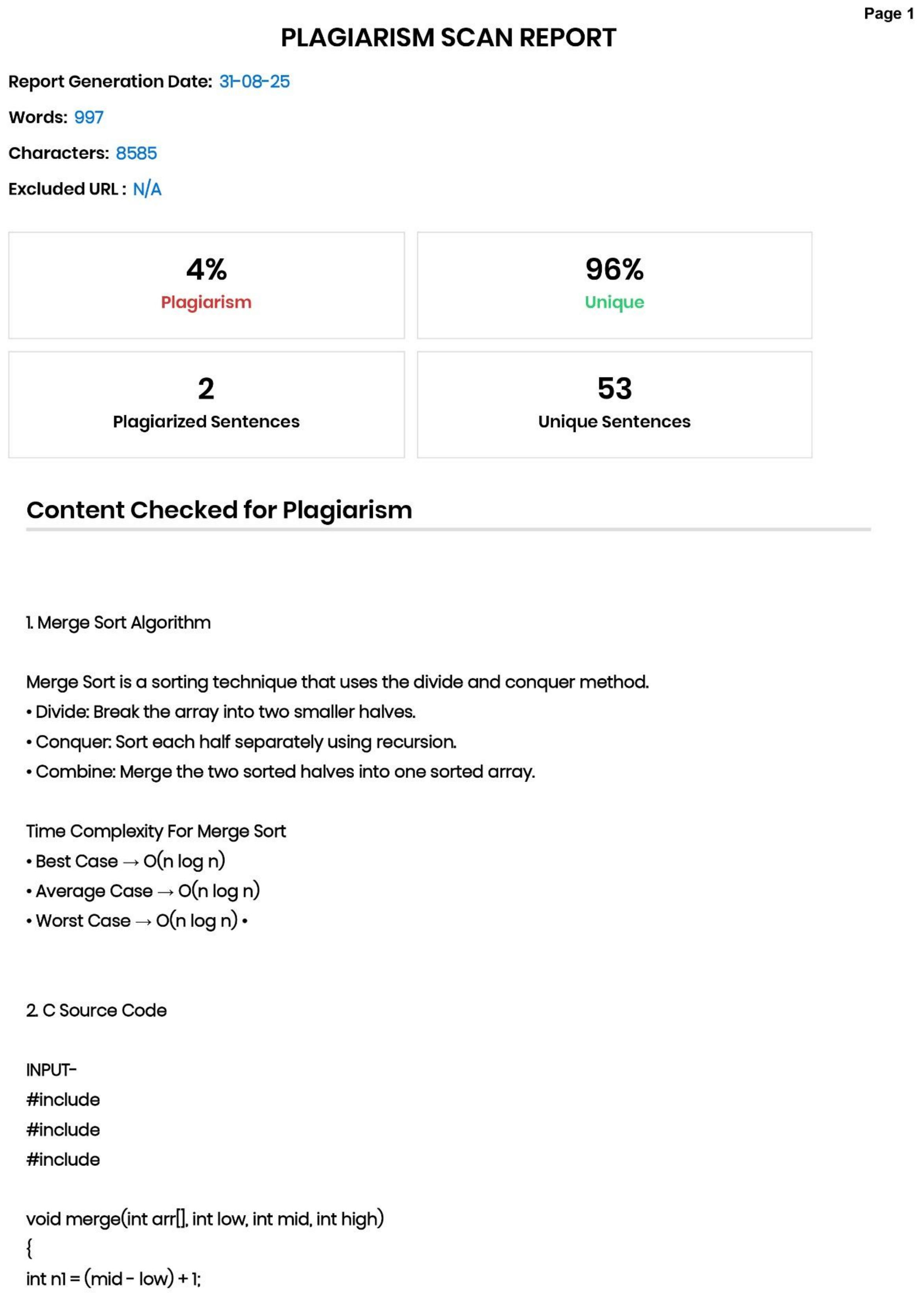
- **Purpose:** To test the sorting of very big integer values.

10. Array of Size 2 (Edge Case)

- **Purpose:** Smallest non-trivial case to check if the algorithm can compare and sort just two numbers.

---

4. Plagiarism Report



Page 1

PLAGIARISM SCAN REPORT

Report Generation Date: 31-08-25

Words: 997

Characters: 8585

Excluded URL : N/A

4% Plagiarism	**96%** Unique
2 Plagiarized Sentences	**53** Unique Sentences

Content Checked for Plagiarism

1. Merge Sort Algorithm

Merge Sort is a sorting technique that uses the divide and conquer method.
• Divide: Break the array into two smaller halves.
• Conquer: Sort each half separately using recursion.
• Combine: Merge the two sorted halves into one sorted array.

Time Complexity For Merge Sort
• Best Case → O(n log n)
• Average Case → O(n log n)
• Worst Case → O(n log n) •

2. C Source Code

INPUT-

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

void merge_sort(int arr[], int low, int high)
{
if (low >= high)
{
return;
}
```

```
else
{
int mid = (high - low) / 2 + low;
merge_sort(arr, low, mid);
merge_sort(arr, mid + 1, high);
merge(arr, low, mid, high);
}
}

void printArray(int arr[], int n)
{
for (int i = 0; i < n; i++)
{
printf("%d ", arr[i]);
}
printf("\n");
}

int main()
{
// Test Case 1 - Small Array
{
int arr[] = {87, 34, 21, 56, 12};
int n = sizeof(arr) / sizeof(arr[0]);
printf("\n--- Test Case 1 (Small array) ---\n");
printf("Input: ");
printArray(arr, n);
merge_sort(arr, 0, n - 1);
printf("Output: ");
printArray(arr, n);
}

// Test Case 2 - Already Sorted Array
{
int arr[] = {11, 12, 13, 14, 15, 16, 17};
int n = sizeof(arr) / sizeof(arr[0]);
printf("\n--- Test Case 2 (Already sorted) ---\n");
printf("Input: ");
printArray(arr, n);
merge_sort(arr, 0, n - 1);
printf("Output: ");
printArray(arr, n);
}
```

```
// Test Case 3 – Reverse sorted array
{
int arr[] = {9, 8, 7, 6, 5, 4, 3};
int n = sizeof(arr) / sizeof(arr[0]);
printf("\n--- Test Case 3 (Reverse sorted) ---\n");
printf("Input: ");
printArray(arr, n);
merge_sort(arr, 0, n - 1);
printf("Output: ");
printArray(arr, n);
}

// Test Case 4 – Array with duplicates
{
int arr[] = {4, 2, 2, 4, 1, 1, 3, 3, 5, 5};
int n = sizeof(arr) / sizeof(arr[0]);
printf("\n--- Test Case 4 (Duplicates) ---\n");
printf("Input: ");
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{
int arr[] = {-5, 10, -2, 7, -9, 0, 3, -1};
int n = sizeof(arr) / sizeof(arr[0]);
printf("\n--- Test Case 5 (With negatives) ---\n");
printf("Input: ");
printArray(arr, n);
merge_sort(arr, 0, n - 1);
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}

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{
int arr[] = {11, 3, 7, 2, 9, 14, 1};
int n = sizeof(arr) / sizeof(arr[0]);
printf("\n--- Test Case 6 (Odd-sized array, n=7) ---\n");
printf("Input: ");
```

```
printArray(arr, n);
merge_sort(arr, 0, n - 1);
printf("Output: ");
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// Test Case 7 – Even-sized array
{
int arr[] = {20, 11, 5, 8, 14, 2, 9, 7, 3, 1};
int n = sizeof(arr) / sizeof(arr[0]);
printf("\n--- Test Case 7 (Even-sized array, n=10) ---\n");
printf("Input: ");
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merge_sort(arr, 0, n - 1);
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}

// Test Case 8 – Large random array (n=1000)
{
int n = 1000;
int arr[n];
for (int i = 0; i < n; i++)
{
arr[i] = rand() % 10000;
}
printf("\n--- Test Case 8 (Large random array, n=1000) ---\n");
merge_sort(arr, 0, n - 1);
printf("Output (first 20 elements): ");
for (int i = 0; i < 20; i++)
printf("%d ", arr[i]);
printf("...\n");
}

// Test Case 9 – Very large random array (n=10000)
{
int n = 10000;
int arr[n];
for (int i = 0; i < n; i++)
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arr[i] = rand() % 100000;
}
printf("\n--- Test Case 9 (Very large random array, n=10000) ---\n");
```

```
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printf("Output (first 20 elements): ");
for (int i = 0; i < 20; i++)
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printf("...\n");
}

// Test Case 10 – All elements same
{
int arr[] = {99, 99, 99, 99, 99, 99, 99, 99, 99, 99};
int n = sizeof(arr) / sizeof(arr[0]);
printf("\n--- Test Case 10 (All elements same) ---\n");
printf("Input: ");
printArray(arr, n);
merge_sort(arr, 0, n - 1);
printf("Output: ");
printArray(arr, n);
}

return 0;
}
```

OUTPUT-

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- Purpose: To make sure Merge Sort works properly when some numbers are repeated.

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- Purpose: To confirm that the algorithm can also sort arrays containing negative values.

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- Purpose: Edge case to see if Merge Sort works when the array has only one element.

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- Purpose: To check how Merge Sort deals with a mix of negative and positive numbers.

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- Purpose: To verify that if all numbers are the same, the algorithm still runs correctly and keeps stability.

9. Array with Large Numbers
- Purpose: To test the sorting of very big integer values.

10. Array of Size 2 (Edge Case)
- Purpose: Smallest non-trivial case to check if the algorithm can compare and sort just two numbers.

4. Plagiarism Report

Matched Sources :

Brainlybrainly.com › question › 14613605[FREE] EX 6.1 How many iterations will th e following for ...

Let's break it down: The first for loop (int i = 0; i < 20; i++) will iterate 20 times. It begins at 0 and increments by 1 up to but not including 20. The second for loop (int i = 1; i

5%

https://brainly.com/question/14613605/