

# Rajalakshmi Engineering College

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## NeoColab\_REC\_CS23231\_DATA STRUCTURES

### REC\_DS using C\_Week 6\_PAH\_Updated

Attempt : 1  
Total Mark : 50  
Marks Obtained : 50

#### Section 1 : Coding

##### 1. Problem Statement

You're a coach managing a list of finishing times for athletes in a race. The times are stored in an array, and you need to sort this array in ascending order to determine the rankings.

You'll use the insertion sort algorithm to accomplish this.

##### ***Input Format***

The first line of input contains an integer  $n$ , representing the number of athletes.

The second line contains  $n$  space-separated integers, each representing the finishing time of an athlete in seconds.

##### ***Output Format***

The output prints the sorted finishing times of the athletes in ascending order.

Refer to the sample output for formatting specifications.

### **Sample Test Case**

Input: 5

75 89 65 90 70

Output: 65 70 75 89 90

### **Answer**

```
// You are using GCC
```

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

```
void insertionSort(int arr[], int n) {
```

```
    int i, key, j;
```

```
    for (i = 1; i < n; i++) {
```

```
        key = arr[i];
```

```
        j = i - 1;
```

```
        // Move elements that are greater than key one position ahead
```

```
        while (j >= 0 && arr[j] > key) {
```

```
            arr[j + 1] = arr[j];
```

```
            j = j - 1;
```

```
        }
```

```
        arr[j + 1] = key;
```

```
    }
```

```
}
```

```
int main() {
```

```
    int n;
```

```
    // Input number of athletes
```

```
    scanf("%d", &n);
```

```
    int times[n];
```

```
    // Input finishing times
```

```
    for (int i = 0; i < n; i++) {
```

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

```
    }
```

```
// Sort using insertion sort
insertionSort(times, n);

// Output sorted times
for (int i = 0; i < n; i++) {
    printf("%d ", times[i]);
}

return 0;
}
```

**Status :** Correct

**Marks :** 10/10

## 2. Problem Statement

You are working as a programmer at a sports academy, and the academy holds various sports competitions regularly.

As part of the academy's system, you need to sort the scores of the participants in descending order using the Quick Sort algorithm.

Write a program that takes the scores of  $n$  participants as input and uses the Quick Sort algorithm to sort the scores in descending order. Your program should display the sorted scores after the sorting process.

### **Input Format**

The first line of input consists of an integer  $n$ , which represents the number of scores.

The second line of input consists of  $n$  integers, which represent scores separated by spaces.

### **Output Format**

Each line of output represents an iteration of the Quick Sort algorithm, displaying the elements of the array at that iteration.

After the iterations are complete, the last line of output prints the sorted scores in descending order separated by space.

Refer to the sample outputs for the formatting specifications.

### **Sample Test Case**

Input: 5

78 54 96 32 53

Output: Iteration 1: 78 54 96 53 32

Iteration 2: 96 54 78

Iteration 3: 78 54

Sorted Order: 96 78 54 53 32

### **Answer**

```
// You are using GCC
```

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

```
// Function to swap two integers
```

```
void swap(int *a, int *b) {
```

```
    int temp = *a;
```

```
    *a = *b;
```

```
    *b = temp;
```

```
}
```

```
// Partition function for descending order
```

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

```
    int pivot = arr[high]; // choosing last element as pivot
```

```
    int i = low - 1;
```

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

```
        // Change condition for descending order
```

```
        if (arr[j] >= pivot) {
```

```
            i++;
```

```
            swap(&arr[i], &arr[j]);
```

```
        }
```

```
    }
```

```
    // Swap pivot into correct place
```

```
    swap(&arr[i + 1], &arr[high]);
```

```
    return i + 1;
```

```
}
```

```
int iteration = 1;
```

```

// QuickSort function
void quickSort(int arr[], int low, int high) {
    if (low < high) {
        int pi = partition(arr, low, high);

        // Print the iteration
        printf("Iteration %d:", iteration++);
        for (int i = low; i <= high; i++) {
            printf(" %d", arr[i]);
        }
        printf("\n");

        quickSort(arr, low, pi - 1);
        quickSort(arr, pi + 1, high);
    }
}

```

```

int main() {
    int n;
    scanf("%d", &n);
    int arr[n];

    for (int i = 0; i < n; i++) {
        scanf("%d", &arr[i]);
    }

    quickSort(arr, 0, n - 1);

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

    return 0;
}

```

**Status :** Correct

**Marks :** 10/10

### 3. Problem Statement

You are working on an optimization task for a sorting algorithm that uses insertion sort. Your goal is to determine the efficiency of the algorithm by counting the number of swaps needed to sort an array of integers.

Write a program that takes an array as input and calculates the number of swaps performed during the insertion sort process.

Example 1:

Input:

5

2 1 3 1 2

Output:

4

Explanation:

Step 1: [2, 1, 3, 1, 2] (No swaps)

Step 2: [1, 2, 3, 1, 2] (1 swap, element 1 shifts 1 place to the left)

Step 3: [1, 2, 3, 1, 2] (No swaps)

Step 4: [1, 1, 2, 3, 2] (2 swaps; element 1 shifts 2 places to the left)

Step 5: [1, 1, 2, 2, 3] (1 swap, element 2 shifts 1 place to the left)

Total number of swaps:  $1 + 2 + 1 = 4$

Example 2:

Input:

7

12 15 1 5 6 14 11

Output:

10

Explanation:

Step 1: [12, 15, 1, 5, 6, 14, 11] (No swaps)

Step 2: [12, 15, 1, 5, 6, 14, 11] (1 swap, element 15 shifts 1 place to the left)

Step 3: [12, 15, 1, 5, 6, 14, 11] (No swaps)

Step 4: [1, 12, 15, 5, 6, 14, 11] (2 swaps, element 1 shifts 2 places to the left)

Step 5: [1, 5, 12, 15, 6, 14, 11] (1 swap, element 5 shifts 1 place to the left)

Step 6: [1, 5, 6, 12, 15, 14, 11] (2 swaps, element 6 shifts 2 places to the left)

Step 7: [1, 5, 6, 12, 14, 15, 11] (1 swap, element 14 shifts 1 place to the left)

Step 8: [1, 5, 6, 11, 12, 14, 15] (3 swaps, element 11 shifts 3 places to the left)

Total number of swaps:  $1 + 2 + 1 + 2 + 1 + 3 = 10$

### ***Input Format***

The first line of input consists of an integer  $n$ , representing the number of elements in the array.

The second line of input consists of  $n$  space-separated integers, representing the elements of the array.

### ***Output Format***

The output prints the number of swaps performed during the insertion sort process.

Refer to the sample output for the formatting specifications.

### ***Sample Test Case***

Input: 5

2 1 3 1 2

Output: 4

### ***Answer***

// You are using GCC

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

```
int countInsertionSortSwaps(int arr[], int n) {  
    int swaps = 0;
```

```
    for (int i = 1; i < n; i++) {  
        int key = arr[i];  
        int j = i - 1;
```

```
        // Move elements greater than key to one position ahead
```

```
        while (j >= 0 && arr[j] > key) {
```

```
            arr[j + 1] = arr[j];
```

```
            j--;
```

```
            swaps++; // Count the swap (or shift)
```

```
        }
```

```
        arr[j + 1] = key;
```

```
    }
```

```
    return swaps;
```

```
}
```

```
int main() {
```

```
    int n;
```

```
    scanf("%d", &n); // Read the number of elements
```

```
    int arr[100]; // Assuming max size won't exceed 100
```

```
    // Read array elements
```

```
    for (int i = 0; i < n; i++) {
```

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

```
    }
```

```
    // Count swaps
```

```
    int swapCount = countInsertionSortSwaps(arr, n);
```

```
    // Print result
```

```
    printf("%d\n", swapCount);
```

```
    return 0;
```

```
}
```

**Status : Correct**

**Marks : 10/10**



#### 4. Problem Statement

Alex is working on a project that involves merging and sorting two arrays. He wants to write a program that merges two arrays, sorts the merged array in ascending order, removes duplicates, and prints the sorted array without duplicates.

Help Alex to implement the program using the merge sort algorithm.

##### ***Input Format***

The first line of input consists of an integer N, representing the number of elements in the first array.

The second line consists of N integers, separated by spaces, representing the elements of the first array.

The third line consists of an integer M, representing the number of elements in the second array.

The fourth line consists of M integers, separated by spaces, representing the elements of the second array.

##### ***Output Format***

The output prints space-separated integers, representing the merged and sorted array in ascending order, with duplicate elements removed.

Refer to the sample output for the formatting specifications.

##### ***Sample Test Case***

Input: 4

1 2 3 4

3

3 4 5

Output: 1 2 3 4 5

##### ***Answer***

// You are using GCC

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

```
// Merge function used in Merge Sort
```

```
void merge(int arr[], int left, int mid, int right) {
```

```
    int i = left, j = mid + 1, k = 0;
```

```
    int temp[right - left + 1];
```

```
    while (i <= mid && j <= right) {
```

```
        if (arr[i] < arr[j])
```

```
            temp[k++] = arr[i++];
```

```
        else
```

```
            temp[k++] = arr[j++];
```

```
    }
```

```
    while (i <= mid)
```

```
        temp[k++] = arr[i++];
```

```
    while (j <= right)
```

```
        temp[k++] = arr[j++];
```

```
    for (i = left, k = 0; i <= right; ++i, ++k)
```

```
        arr[i] = temp[k];
```

```
}
```

```
// Recursive Merge Sort function
```

```
void mergeSort(int arr[], int left, int right) {
```

```
    if (left < right) {
```

```
        int mid = (left + right) / 2;
```

```
        mergeSort(arr, left, mid);
```

```
        mergeSort(arr, mid + 1, right);
```

```
        merge(arr, left, mid, right);
```

```
    }
```

```
}
```

```
// Function to remove duplicates from a sorted array
```

```
int removeDuplicates(int arr[], int n) {
```

```
    if (n == 0) return 0;
```

```
    int temp[n], j = 0;
```

```
    for (int i = 0; i < n - 1; i++) {
```

```
        if (arr[i] != arr[i + 1])
```

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

```
    }
```

```
temp[j++] = arr[n - 1];
for (int i = 0; i < j; i++)
    arr[i] = temp[i];
return j;
}
```

```
int main() {
    int n, m;
    scanf("%d", &n);
    int arr1[n];
    for (int i = 0; i < n; i++)
        scanf("%d", &arr1[i]);
```

```
    scanf("%d", &m);
    int arr2[m];
    for (int i = 0; i < m; i++)
        scanf("%d", &arr2[i]);
```

```
    int merged[n + m];
    for (int i = 0; i < n; i++)
        merged[i] = arr1[i];
    for (int i = 0; i < m; i++)
        merged[n + i] = arr2[i];
```

```
    int total = n + m;
    mergeSort(merged, 0, total - 1);
    int newSize = removeDuplicates(merged, total);
```

```
    for (int i = 0; i < newSize; i++)
        printf("%d ", merged[i]);
```

```
    return 0;
}
```

**Status :** Correct

**Marks :** 10/10

## 5. Problem Statement

Vishnu, a math enthusiast, is given a task to explore the magic of numbers. He has an array of positive integers, and his goal is to find the integer with the highest digit sum in the sorted array using the merge sort algorithm.

You have to assist Vishnu in implementing the merge sort algorithm.

### ***Input Format***

The first line of input consists of an integer N, representing the number of elements in the array.

The second line consists of N space-separated integers, representing the array elements.

### ***Output Format***

The first line of output prints "The sorted array is: " followed by the sorted array, separated by a space.

The second line prints "The integer with the highest digit sum is: " followed by an integer representing the highest-digit sum.

Refer to the sample output for formatting specifications.

### ***Sample Test Case***

Input: 5

123 456 789 321 654

Output: The sorted array is: 123 321 456 654 789

The integer with the highest digit sum is: 789

### ***Answer***

```
// You are using GCC
#include <stdio.h>
```

```
// Function to calculate digit sum
```

```
int digitSum(int num) {
    int sum = 0;
    while (num > 0) {
        sum += num % 10;
        num /= 10;
    }
    return sum;
}
```

```
// Merge function
void merge(int arr[], int left, int mid, int right) {
    int n1 = mid - left + 1;
    int n2 = right - mid;
```

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

```
    // Copy data
    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];
```

```
    // Merge the temp arrays back into arr
    int 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 - left) / 2;
```

```
        // Sort both halves
        mergeSort(arr, left, mid);
        mergeSort(arr, mid + 1, right);
```

```
        // Merge sorted halves
```

```

    merge(arr, left, mid, right);
}
}

// Main function
int main() {
    int N;
    scanf("%d", &N);

    int arr[N];

    // Input elements
    for (int i = 0; i < N; i++) {
        scanf("%d", &arr[i]);
    }

    // Sort array using merge sort
    mergeSort(arr, 0, N - 1);

    // Find number with highest digit sum
    int maxSum = -1;
    int result = -1;
    for (int i = 0; i < N; i++) {
        int sum = digitSum(arr[i]);
        if (sum > maxSum) {
            maxSum = sum;
            result = arr[i];
        }
    }

    // Output
    printf("The sorted array is: ");
    for (int i = 0; i < N; i++) {
        printf("%d ", arr[i]);
    }
    printf("\n");

    printf("The integer with the highest digit sum is: %d\n", result);

    return 0;
}

```

**Status :** Correct

**Marks :** 10/10