Shri Vile Parle Kelavani Mandal's
DWARKADAS J. SANGHVI COLLEGE OF ENGINEERING
(Autonomous College Affiliated to the University of Mumbai)
NAAC Accredited with "A" Grade (CGPA : 3.18)

DEPARTMENT OF INFORMATION TECHNOLOGY

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COURSE CODE: DJS22ITL302 **CLASS: S. Y. B. Tech. SemIII**

(I1-1)

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EXPERIMENT NO. 9

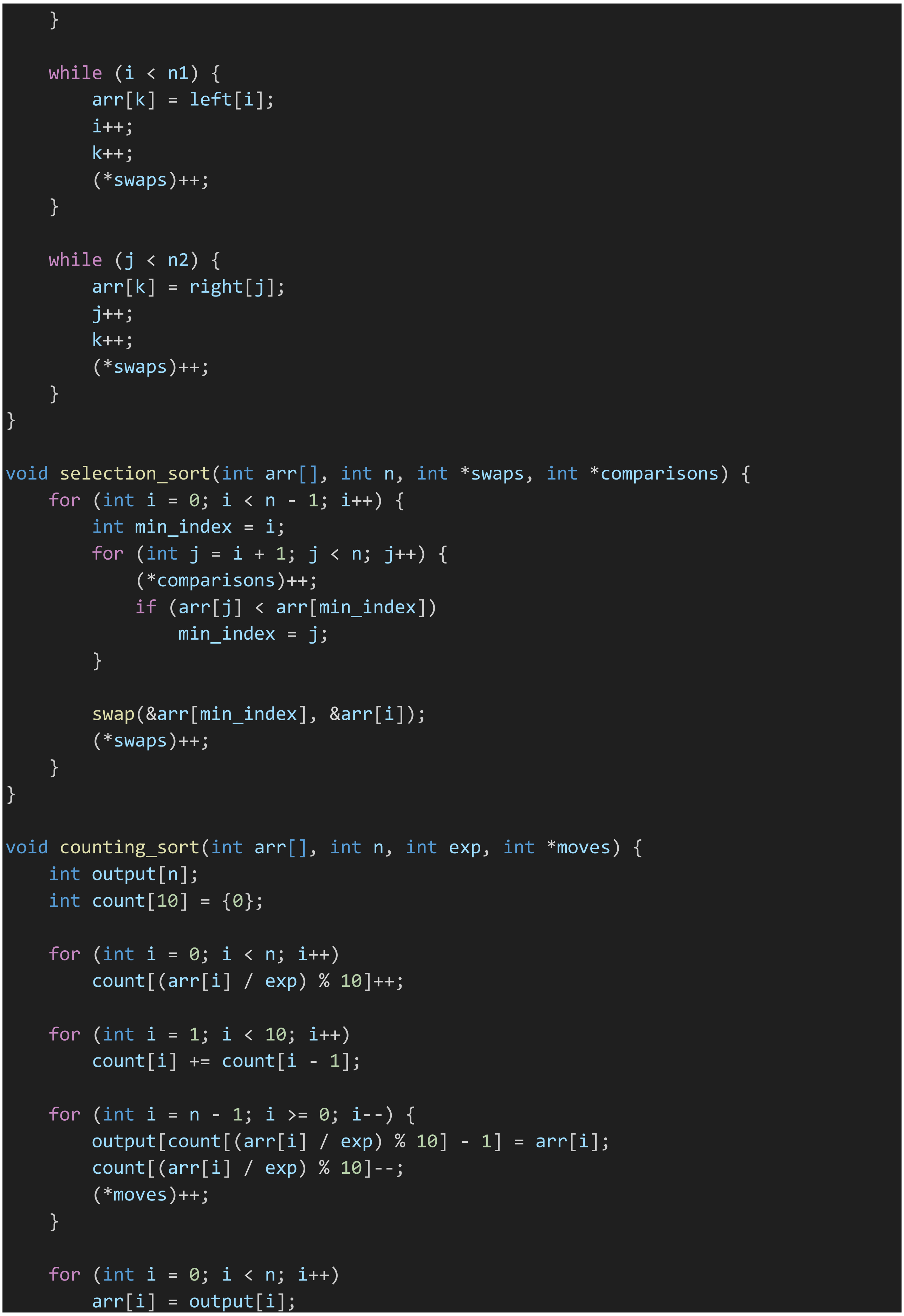
CO/LO: Solve the problem using sorting techniques.

Objective: Write a program to implement different quadratic sorting algorithms with various parameters. Analyze the performance of all the algorithms.

Code

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

// Function prototypes
void quick_sort(int arr[], int low, int high, int *swaps, int *comparisons);
void merge_sort(int arr[], int low, int high, int *swaps, int *comparisons);
void selection_sort(int arr[], int n, int *swaps, int *comparisons);
void radix_sort(int arr[], int n, int *moves);

// Helper functions
void print_array(int arr[], int n);
void swap(int *a, int *b);
void counting_sort(int arr[], int n, int exp, int *moves);

int main() {
    srand(time(NULL));

    int n;
    printf("Enter the number of elements: ");
    scanf("%d", &n);

    int arr[n];
    printf("Enter the elements:\n");
    for (int i = 0; i < n; i++) {
        scanf("%d", &arr[i]);
    }

    printf("\nOriginal array: ");
    print_array(arr, n);

    int choice;
    printf("\nSelect sorting algorithm:\n1. Quick Sort\n2. Merge Sort\n3.
Selection Sort\n4. Radix Sort\n");
    scanf("%d", &choice);

    int swaps = 0, comparisons = 0, moves = 0;
    clock_t start_time, end_time;

    start_time = clock();
    switch (choice) {
        case 1:
            quick_sort(arr, 0, n - 1, &swaps, &comparisons);
            break;
        case 2:
            merge_sort(arr, 0, n - 1, &swaps, &comparisons);
            break;
        case 3:
            selection_sort(arr, n, &swaps, &comparisons);
            break;
        case 4:
            radix_sort(arr, n, &moves);
            break;
        default:
            printf("Invalid choice\n");
            return 1;
    }
    end_time = clock();

    printf("\nSorted array: ");
    print_array(arr, n);

    printf("\nPerformance Analysis:\n");
    printf("Number of swaps: %d\n", swaps);
    printf("Number of comparisons: %d\n", comparisons);
    printf("Number of shifts/movements: %d\n", moves);
    printf("Total time taken to sort: %lf seconds\n", ((double)(end_time -
start_time)) / CLOCKS_PER_SEC);

    return 0;
}

void quick_sort(int arr[], int low, int high, int *swaps, int *comparisons) {
    if (low < high) {
        int pivot = arr[high];
        int i = low - 1;

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

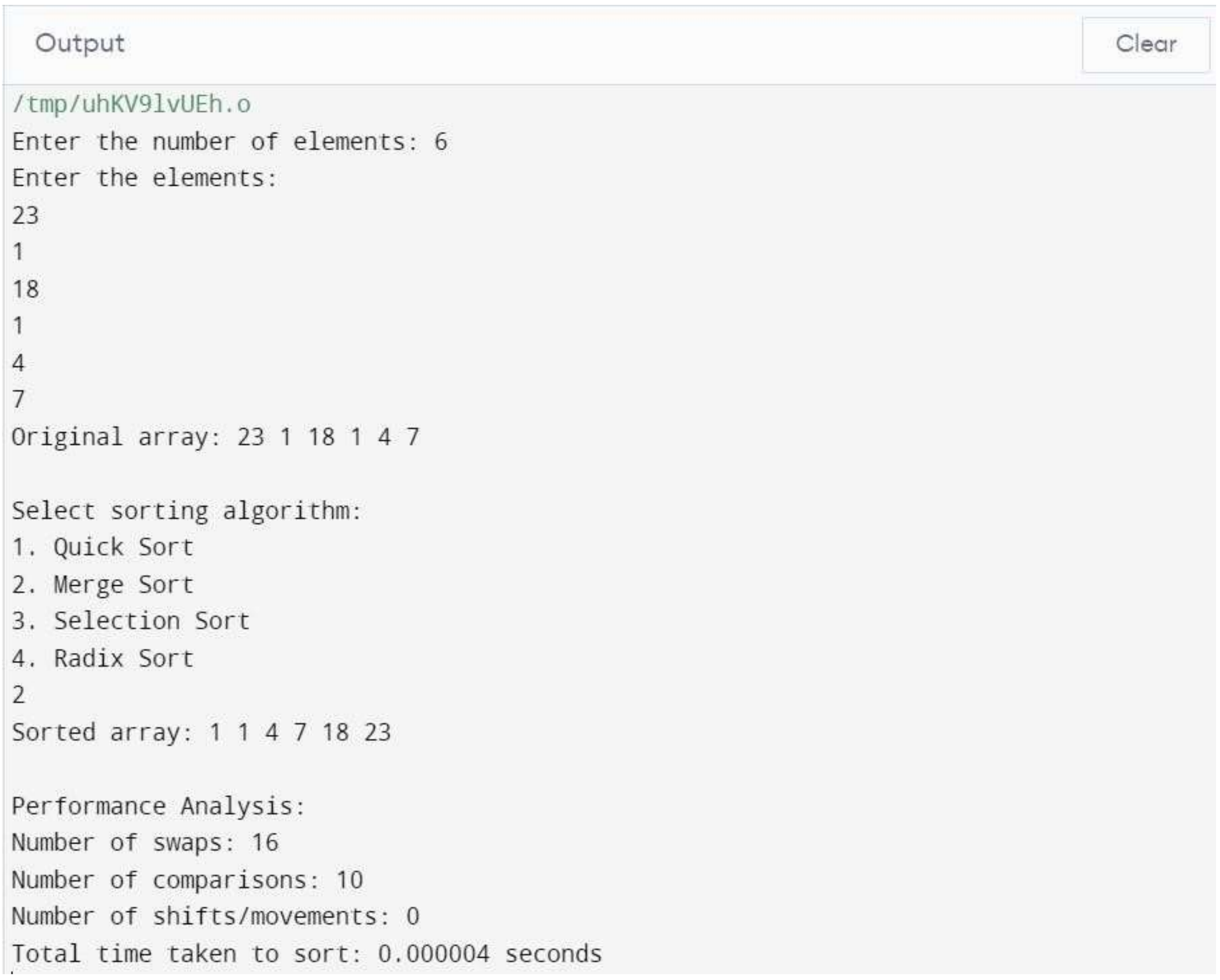
```c
            (*comparisons)++;
            if (arr[j] <= pivot) {
                i++;
                swap(&arr[i], &arr[j]);
                (*swaps)++;
            }
        }

        swap(&arr[i + 1], &arr[high]);
        (*swaps)++;
        int partition_index = i + 1;

        quick_sort(arr, low, partition_index - 1, swaps, comparisons);
        quick_sort(arr, partition_index + 1, high, swaps, comparisons);
    }
}

void merge_sort(int arr[], int low, int high, int *swaps, int *comparisons) {
    if (low < high) {
        int mid = low + (high - low) / 2;
        merge_sort(arr, low, mid, swaps, comparisons);
        merge_sort(arr, mid + 1, high, swaps, comparisons);
        merge(arr, low, mid, high, swaps, comparisons);
    }
}

void merge(int arr[], int low, int mid, int high, int *swaps, int *comparisons) {
    int n1 = mid - low + 1;
    int n2 = high - mid;

    int left[n1], 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 i = 0, j = 0, k = low;
    while (i < n1 && j < n2) {
        (*comparisons)++;
        if (left[i] <= right[j]) {
            arr[k] = left[i];
            i++;
        } else {
            arr[k] = right[j];
            j++;
        }
        k++;
        (*swaps)++;
```



```
    }

    while (i < n1) {
        arr[k] = left[i];
        i++;
        k++;
        (*swaps)++;
    }

    while (j < n2) {
        arr[k] = right[j];
        j++;
        k++;
        (*swaps)++;
    }
}

void selection_sort(int arr[], int n, int *swaps, int *comparisons) {
    for (int i = 0; i < n - 1; i++) {
        int min_index = i;
        for (int j = i + 1; j < n; j++) {
            (*comparisons)++;
            if (arr[j] < arr[min_index])
                min_index = j;
        }

        swap(&arr[min_index], &arr[i]);
        (*swaps)++;
    }
}

void counting_sort(int arr[], int n, int exp, int *moves) {
    int output[n];
    int count[10] = {0};

    for (int i = 0; i < n; i++)
        count[(arr[i] / exp) % 10]++;

    for (int i = 1; i < 10; i++)
        count[i] += count[i - 1];

    for (int i = n - 1; i >= 0; i--) {
        output[count[(arr[i] / exp) % 10] - 1] = arr[i];
        count[(arr[i] / exp) % 10]--;
        (*moves)++;
    }

    for (int i = 0; i < n; i++)
        arr[i] = output[i];
```

```c
}

void radix_sort(int arr[], int n, int *moves) {
    int max = 0;
    for (int i = 0; i < n; i++) {
        if (arr[i] > max)
            max = arr[i];
    }

    for (int exp = 1; max / exp > 0; exp *= 10)
        counting_sort(arr, n, exp, moves);
}

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

void swap(int *a, int *b) {
    int temp = *a;
    *a = *b;
    *b = temp;
}
```

OUTPUT :



```
/tmp/uhKV9lvUEh.o
Enter the number of elements: 6
Enter the elements:
23
1
18
1
4
7
Original array: 23 1 18 1 4 7

Select sorting algorithm:
1. Quick Sort
2. Merge Sort
3. Selection Sort
4. Radix Sort
2
Sorted array: 1 1 4 7 18 23

Performance Analysis:
Number of swaps: 16
Number of comparisons: 10
Number of shifts/movements: 0
Total time taken to sort: 0.000004 seconds
```

Conclusion:

This C code implements a program for sorting an array using four different sorting algorithms: Quick Sort, Merge Sort, Selection Sort, and Radix Sort. The program allows the user to input the number of elements in the array and the elements themselves. It then provides the option to choose one of the sorting algorithms for sorting the array. Thus implemented sort successfully.

Website References:

- Geeksforgeeks

-Javatpoint