

# Design and Analysis of Algorithms

## Sorting

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1. Write a program to implement bubble sort.

Code:

```
#include <stdio.h>

void bubbleSort(int arr[],int n){
    for(int i=0;i<n-1;i++){
        for(int j=0;j<n-i-1;j++){
            if(arr[j]>arr[j+1]){
                int temp=arr[j];
                arr[j]=arr[j+1];
                arr[j+1]=temp;
            }
        }
    }
}

int main() {
    int n,i;
    printf("Enter the number of elements:");
    scanf("%d",&n);
    int arr[n];
    for(i=0;i<n;i++){
        printf("Element %d:",i+1);
        scanf("%d",&arr[i]);
    }

    bubbleSort(arr, n);

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

    return 0;
}
```

Output:

```
C:\Sem-4\DA\Sorting>gcc bubble.c  
C:\Sem-4\DA\Sorting>a  
Enter the number of elements:5  
Element 1:1906  
Element 2:19  
Element 3:6  
Element 4:11  
Element 5:3
```

**Space complexity of Bubble sort:**  $O(1)$

**Time complexity of Bubble sort:**  $O(n^2)$

2. Write a program to implement insertion sort.

Code:

```
#include <stdio.h>

void insertionSort(int arr[],int n) {
    for(int i=1;i<n;i++) {
        int a=arr[i];
        int j = i - 1;

        while(j>=0 && arr[j]>a) {
            arr[j+1]=arr[j];
            j--;
        }
        arr[j+1]=a;
    }
}

int main() {
    int n,i;
    printf("Enter the number of elements:");
    scanf("%d",&n);
    int arr[n];
    for(i=0;i<n;i++){
        printf("Element %d:",i+1);
        scanf("%d",&arr[i]);
    }

    insertionSort(arr,n);

    printf("Insertion Sorted array: ");
    for(int i=0;i<n;i++)
        printf("%d ",arr[i]);

    return 0;
}
```

Output:

```
C:\Sem-4\DA\Sorting>gcc insertion.c  
C:\Sem-4\DA\Sorting>a  
Enter the number of elements:5  
Element 1:5  
Element 2:9  
Element 3:1  
Element 4:7  
Element 5:2  
Insertion Sorted array: 1 2 5 7 9
```

**Space complexity of Insertion sort:**  $O(1)$

**Time complexity of Insertion sort:**  $O(n^2)$

### 3. Write a program to implement selection sort.

Code:

```
#include <stdio.h>

void selectionSort(int arr[],int n) {
    for(int i=0;i<n-1;i++) {
        int min =i;

        for(int j=i+1;j<n;j++) {
            if(arr[j]<arr[min])
                min=j;
        }
        int temp=arr[min];
        arr[min]=arr[i];
        arr[i]=temp;
    }
}

int main() {
    int n,i;
    printf("Enter the number of elements:");
    scanf("%d",&n);
    int arr[n];
    for(i=0;i<n;i++){
        printf("Element %d:",i+1);
        scanf("%d",&arr[i]);
    }

    selectionSort(arr,n);

    printf("Selection Sorted array: ");
    for(int i=0;i<n;i++)
        printf("%d ",arr[i]);

    return 0;
}
```

Output:

```
C:\Sem-4\DAASorting>gcc selection.c  
C:\Sem-4\DAASorting>a  
Enter the number of elements:6  
Element 1:732  
Element 2:4984  
Element 3:843  
Element 4:8  
Element 5:94  
Element 6:100  
Selection Sorted array: 8 94 100 732 843 4984
```

**Space complexity of Selection sort:** O(1)

**Time complexity of Selection sort:** O( $n^2$ )

#### 4. Write a program to implement Bucket Sort.

Code:

```
#include <stdio.h>

void insertionSort(float bucket[], int n) {
    int i, j;
    float key;
    for (i = 1; i < n; i++) {
        key = bucket[i];
        j = i - 1;
        while (j >= 0 && bucket[j] > key) {
            bucket[j + 1] = bucket[j];
            j--;
        }
        bucket[j + 1] = key;
    }
}

void bucketSort(float arr[], int n) {
    int i, j;

    float min = arr[0], max = arr[0];
    for (i = 1; i < n; i++) {
        if (arr[i] < min) min = arr[i];
        if (arr[i] > max) max = arr[i];
    }

    float bucket[n][n];
    int count[n];

    for (i = 0; i < n; i++)
        count[i] = 0;

    for (i = 0; i < n; i++) {
        int bi = (int)((arr[i] - min) / (max - min)) * (n - 1));
        bucket[bi][count[bi]++] = arr[i];
    }

    for (i = 0; i < n; i++)
        insertionSort(bucket[i], count[i]);

    int index = 0;
    for (i = 0; i < n; i++)
        for (j = 0; j < count[i]; j++)
            arr[index++] = bucket[i][j];
}
```

```
}

int main() {
    int n, i;
    float arr[100];

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

    printf("Enter elements: ");
    for (i = 0; i < n; i++)
        scanf("%f", &arr[i]);

    bucketSort(arr, n);

    printf("Sorted array: ");
    for (i = 0; i < n; i++)
        printf("%.2f ", arr[i]);

    return 0;
}
```

**Output:**

```
C:\Sem-4\DAASorting>gcc bucket.c

C:\Sem-4\DAASorting>a
Enter number of elements: 5
Enter elements :4 2 8 10 4
Sorted array:2.00 4.00 4.00 8.00 10.00
```

**Space complexity of Bucket sort:**  $O(n^2)$

**Time complexity of Bucket sort:**  $O(n^2)$

5. Write a program to implement Heap sort .

i) Max heap sort

Code:

```
#include <stdio.h>

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

void maxHeapify(int arr[], int n, int i) {
    int largest = i;
    int left = 2*i + 1;
    int right = 2*i + 2;

    if (left < n && arr[left] > arr[largest])
        largest = left;

    if (right < n && arr[right] > arr[largest])
        largest = right;

    if (largest != i) {
        swap(&arr[i], &arr[largest]);
        maxHeapify(arr, n, largest);
    }
}

void buildMaxHeap(int arr[], int n) {
    for (int i = n/2 - 1; i >= 0; i--)
        maxHeapify(arr, n, i);
}

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

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

    buildMaxHeap(arr, n);
}
```

```
    printf("Max Heap:\n");
    for (i = 0; i < n; i++)
        printf("%d ", arr[i]);

    return 0;
}
```

Output:

```
C:\Sem-4\DAASorting>gcc maxheap.c

C:\Sem-4\DAASorting>a
Enter number of elements: 5
1 7 5 10 3
Max Heap:
10 7 5 1 3
```

ii) Min Heap sort

Code:

```
#include <stdio.h>

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

void minHeapify(int arr[], int n, int i) {
    int smallest = i;
    int left = 2*i + 1;
    int right = 2*i + 2;

    if (left < n && arr[left] < arr[smallest])
        smallest = left;

    if (right < n && arr[right] < arr[smallest])
        smallest = right;

    if (smallest != i) {
```

```

        swap(&arr[i], &arr[smallest]);
        minHeapify(arr, n, smallest);
    }
}

void buildMinHeap(int arr[], int n) {
    for (int i = n/2 - 1; i >= 0; i--)
        minHeapify(arr, n, i);
}

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

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

    buildMinHeap(arr, n);

    printf("Min Heap:\n");
    for (i = 0; i < n; i++)
        printf("%d ", arr[i]);

    return 0;
}

```

**Output:**

```

C:\Sem-4\DA\Sorting>gcc minheap.c

C:\Sem-4\DA\Sorting>a
Enter number of elements: 5
1 7 5 10 3
Min Heap:
1 3 5 10 7

```

**Space complexity of Heap sort:**  $O(\log n)$

**Time complexity of Heap sort:**  $O(n \log n)$

## 6. Write a program to implement Breadth First Search.

Code:

```
#include <stdio.h>

int adj[10][10], visited[10], queue[10];
int n, front = 0, rear = -1;

void bfs(int start) {
    int i;
    visited[start] = 1;
    queue[++rear] = start;

    while (front <= rear) {
        int v = queue[front++];
        printf("%d ", v);

        for (i = 0; i < n; i++) {
            if (adj[v][i] == 1 && !visited[i]) {
                visited[i] = 1;
                queue[++rear] = i;
            }
        }
    }
}

int main() {
    int i, j, start;
    printf("Enter number of vertices: ");
    scanf("%d", &n);

    printf("Enter adjacency matrix:\n");
    for (i = 0; i < n; i++)
        for (j = 0; j < n; j++)
            scanf("%d", &adj[i][j]);

    for (i = 0; i < n; i++)
        visited[i] = 0;

    printf("Enter starting vertex: ");
    scanf("%d", &start);

    printf("BFS traversal: ");
    bfs(start);

    return 0;
}
```

```
}
```

Output:

```
C:\Sem-4\DAASorting>gcc bfs.c  
C:\Sem-4\DAASorting>a  
Enter number of vertices: 5  
Enter adjacency matrix:  
0 1 1 1 0  
1 0 0 0 1  
1 0 0 0 1  
1 0 0 0 1  
0 1 1 1 0  
Enter starting vertex: 0  
BFS traversal: 0 1 2 3 4
```

**Space complexity of Breadth First Search:**  $O(n^2)$

**Time complexity of Breadth First Search:**  $O(n^2)$

## 7. Write a program to implement Depth First Search.

Code:

```
#include <stdio.h>

int adj[10][10], visited[10], n;

void dfs(int v) {
    int i;
    visited[v] = 1;
    printf("%d ", v);

    for (i = 0; i < n; i++) {
        if (adj[v][i] == 1 && !visited[i])
            dfs(i);
    }
}

int main() {
    int i, j, start;
    printf("Enter number of vertices: ");
    scanf("%d", &n);

    printf("Enter adjacency matrix:\n");
    for (i = 0; i < n; i++)
        for (j = 0; j < n; j++)
            scanf("%d", &adj[i][j]);

    for (i = 0; i < n; i++)
        visited[i] = 0;

    printf("Enter starting vertex: ");
    scanf("%d", &start);

    printf("DFS traversal: ");
    dfs(start);

    return 0;
}
```

Output:

```
C:\Sem-4\DAASorting>gcc dfs.c  
C:\Sem-4\DAASorting>a  
Enter number of vertices: 5  
Enter adjacency matrix:  
0 1 1 1 0  
1 0 0 0 1  
1 0 0 0 1  
1 0 0 0 1  
0 1 1 1 0  
Enter starting vertex: 0  
DFS traversal: 0 1 4 2 3
```

**Space complexity of Depth First Search:**  $O(n^2)$

**Time complexity of Depth First Search:**  $O(n^2)$