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RNS INSTITUTE OF TECHNOLOGY

Affiliated to VTU, Recognized by GOK, Approved by AICTE, New Delhi
(NAAC 'A+ Grade' Accredited, NBA Accredited (UG - CSE, ECE, ISE, EIE and EEE)
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Estd : 2001

DEPARTMENT OF AI & ML

ANALYSIS & DESIGN OF ALGORITHMS LAB MANUAL

(BCSL404)

(As per Visvesvaraya Technological University Course type- PCCL)

DEPARTMENT OF CSE(AI & ML)

R N S Institute of Technology

Bengaluru-98

Name: ______________________

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DEPARTMENT OF AI & ML

Vision of the Department

Empowering AI & ML Engineers to seamlessly integrate society and technology.

Mission of the Department

The Department of AI&ML will make every effort to promote an intellectual and ethical environment by

- To Inculcate, strong mathematical foundations as applied to AIML domain.
- To Equip AIML graduates with skills to meet Industrial and Societal challenges.
- To Foster ethical values & engineering norms and standards in AIML graduates.

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Trademark

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PROGRAM LIST AND CONDUCTION PLAN

Sl. NO.	***Date Week***	***Program Description***	***Page No.***
1	29/04/2024 29/04/2024	Design and implement C/C++ Program to find Minimum Cost Spanning Tree of a given connected undirected graph using Kruskal's algorithm	***7-10***
2	6/05/2024 6/05/2024	Design and implement C/C++ Program to find Minimum Cost Spanning Tree of a given connected undirected graph using Prim's algorithm.	***11-13***
3	13/05/2024 13/05/2024	a. Design and implement C/C++ Program to solve All-Pairs Shortest Paths problem using Floyd's algorithm. b. Design and implement C/C++ Program to find the transitive closure using Warshal's algorithm	***13-19***
4	20/05/2024 20/05/2024	Design and implement C/C++ Program to find shortest paths from a given vertex in a weighted connected graph to other vertices using Dijkstra's algorithm	***20-22***
5	27/05/2024 27/05/2024	Design and implement C/C++ Program to obtain the Topological ordering of vertices in a given digraph.	***23-25***
6	03/06/2024 03/06/2024	Design and implement C/C++ Program to solve 0/1 Knapsack problem using Dynamic Programming method.	***26-27***
7	10/06/2024 10/06/2024	Design and implement C/C++ Program to solve discrete Knapsack and continuous Knapsack problems using greedy approximation method.	***28-29***
8	17/06/2024 17/06/2024	Design and implement C/C++ Program to find a subset of a given set S = {sl , s2,. ... ,sn} of n positive integers whose sum is equal to a given positive integer d.	***30-31***
9	24/06/2024 24/06/2024	Design and implement C/C++ Program to sort a given set of n integer elements using Selection Sort method and compute its time complexity. Run the program for varied values of n> 5000 and record the time taken to sort. Plot a graph of the time taken versus	***32-34***

		n. The elements can be read from a file or can be generated using 35the random number generator	
10	08/07/2024 08/07/2024	Design and implement C/C++ Program to sort a given set of n integer elements using Quick Sort method and compute its time complexity. Run the program for varied values of n> 5000 and record the time taken to sort. Plot a graph of the time taken versus n. The elements can be read from a file or can be generated using the random number generator.	***35-38***
11	22/07/2024 22/07/2024	Design and implement C/C++ Program to sort a given set of n integer elements using Merge Sort method and compute its time complexity. Run the program for varied values of n> 5000, and record the time taken to sort. Plot a graph of the time taken versus n. The elements can be read from a file or can be generated using the random number generator.	***39-43***
12	29/07/2024 29/07/2024	Design and implement C/C++ Program for N Queen's problem using Backtracking	***44-46***
13	5/08/2024	Internals	

Course objectives:

1. To design and implement various algorithms in C/C++ programming using suitable development tools to address different computational challenges.

2. To apply diverse design strategies for effective problem-solving.

3. To Measure and compare the performance of different algorithms to determine their efficiency and suitability for specific tasks

Course outcomes (Course Skill Set): At the end of the course, the student will be able to:

1. Develop programs to solve computational problems using suitable algorithm design strategy.

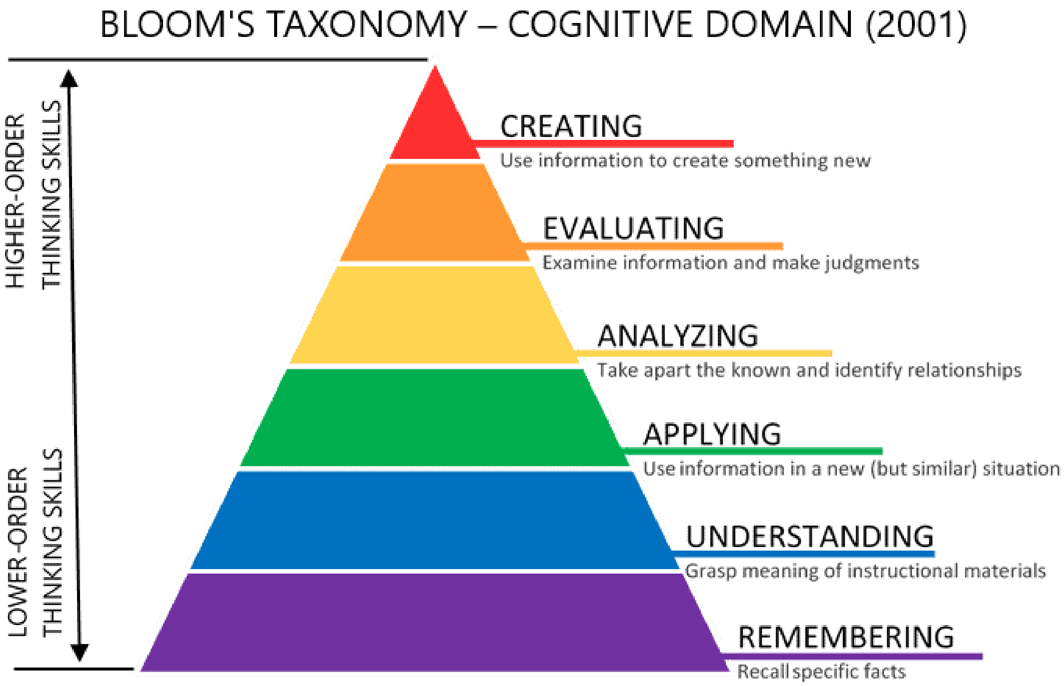
2. Compare algorithm design strategies by developing equivalent programs and observing running times for analysis (Empirical)

3. Make use of suitable integrated development tools to develop programs.

4. Choose appropriate algorithm design techniques to develop solution to the computational and complex problems.

5. Demonstrate and present the development of program, its execution and running time(s) and record the results/inferences

REVISED BLOOMS TAXONOMY (RBT)



Program 1

1.Design and implement C Program to find Minimum Cost Spanning Tree of a given connected undirected graph using Kruskal's algorithm.

PROGRAM:

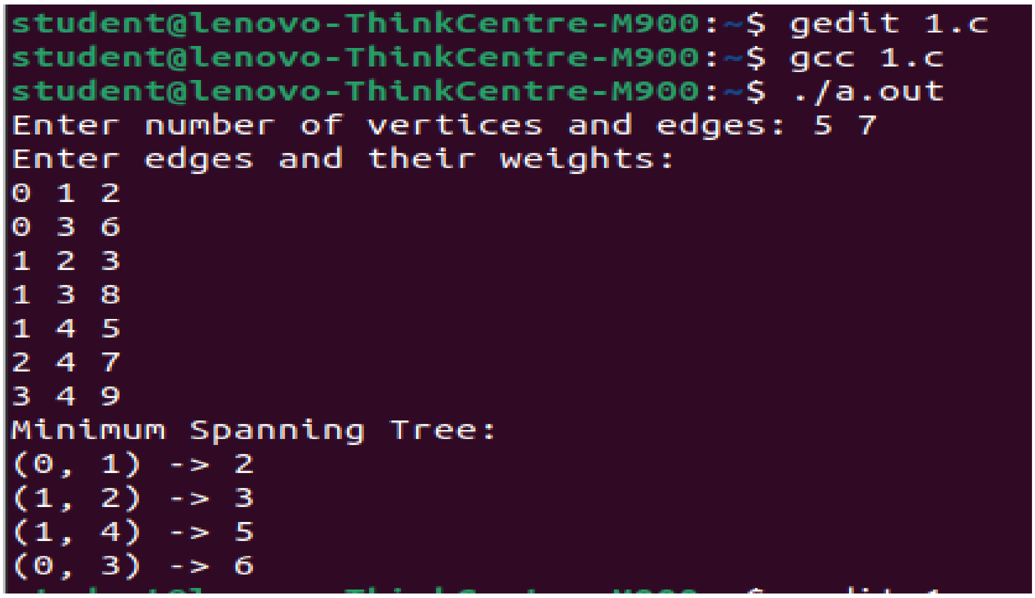
```
#include <stdio.h>
#include <stdlib.h>

#define MAX_EDGES 1000

typedef struct Edge {
    int src, dest, weight;
} Edge;

typedef struct Graph {
    int V, E;
    Edge edges[MAX_EDGES];
} Graph;

typedef struct Subset {
    int parent, rank;
} Subset;

Graph* createGraph(int V, int E) {
    Graph* graph = (Graph*) malloc(sizeof(Graph));
    graph->V = V;
    graph->E = E;
    return graph;
}

int find(Subset subsets[], int i) {
    if (subsets[i].parent != i) {
```

```
        subsets[i].parent = find(subsets, subsets[i].parent);
    }
    return subsets[i].parent;
}

void Union(Subset subsets[], int x, int y) {
    int xroot = find(subsets, x);
    int yroot = find(subsets, y);

    if (subsets[xroot].rank < subsets[yroot].rank) {
        subsets[xroot].parent = yroot;
    } else if (subsets[xroot].rank > subsets[yroot].rank) {
        subsets[yroot].parent = xroot;
    } else {
        subsets[yroot].parent = xroot;
        subsets[xroot].rank++;
    }
}

int compare(const void* a, const void* b) {
    Edge* a_edge = (Edge*) a;
    Edge* b_edge = (Edge*) b;
    return a_edge->weight - b_edge->weight;
}

void kruskalMST(Graph* graph) {
    Edge mst[graph->V];
    int e = 0, i = 0;

    qsort(graph->edges, graph->E, sizeof(Edge), compare);

    Subset* subsets = (Subset*) malloc(graph->V * sizeof(Subset));
```

```
    for (int v = 0; v < graph->V; ++v) {
        subsets[v].parent = v;
        subsets[v].rank = 0;
    }

    while (e < graph->V - 1 && i < graph->E) {
        Edge next_edge = graph->edges[i++];

        int x = find(subsets, next_edge.src);
        int y = find(subsets, next_edge.dest);

        if (x != y) {
            mst[e++] = next_edge;
            Union(subsets, x, y);
        }
    }

    printf("Minimum Spanning Tree:\n");
    for (i = 0; i < e; ++i) {
        printf("(%d, %d) -> %d\n", mst[i].src, mst[i].dest, mst[i].weight);
    }
}

int main() {
    int V, E;
    printf("Enter number of vertices and edges: ");
    scanf("%d %d", &V, &E);

    Graph* graph = createGraph(V, E);

    printf("Enter edges and their weights:\n");
    for (int i = 0; i < E; ++i) {
```

```
        scanf("%d %d %d", &graph->edges[i].src, &graph->edges[i].dest, &graph->edges[i].weight);
    }

    kruskalMST(graph);

    return 0;
}
```

OUTPUT:



Program 2

Design and implement C Program to find Minimum Cost Spanning Tree of a given connected undirected graph using Prim's algorithm.

```
#include <stdio.h>

#include <limits.h>

#define V_MAX 100 // Maximum number of vertices

// Function to find the vertex with the minimum key value, from the set of vertices not yet included in the MST

int minKey(int key[], int mstSet[], int V) {

    int min = INT_MAX, min_index;

    for (int v = 0; v < V; v++)

        if (mstSet[v] == 0 && key[v] < min)

            min = key[v], min_index = v;

    return min_index;

}

// Function to print the constructed MST stored in parent[]

void printMST(int parent[], int n, int graph[V_MAX][V_MAX], int V) {

    printf("Edge   Weight\n");

    for (int i = 1; i < V; i++)

        printf("%d - %d     %d \n", parent[i], i, graph[i][parent[i]]);

}


// Function to construct and print MST for a graph represented using adjacency matrix representation

void primMST(int graph[][V_MAX], int V) {

    int parent[V_MAX]; // Array to store constructed MST

    int key[V_MAX]; // Key values used to pick minimum weight edge in cut

    int mstSet[V_MAX]; // To represent set of vertices not yet included in MST


    // Initialize all keys as INFINITE, mstSet[] as 0

    for (int i = 0; i < V; i++)

        key[i] = INT_MAX, mstSet[i] = 0;
```

```
    // Always include first 1st vertex in MST. Make key 0 so that this vertex is picked as the first vertex
    key[0] = 0;
    parent[0] = -1; // First node is always the root of MST

    // The MST will have V vertices
    for (int count = 0; count < V - 1; count++) {
        // Pick the minimum key vertex from the set of vertices not yet included in MST
        int u = minKey(key, mstSet, V);

        // Add the picked vertex to the MST set
        mstSet[u] = 1;

        // Update key value and parent index of the adjacent vertices of the picked vertex
        // Consider only those vertices which are not yet included in the MST
        for (int v = 0; v < V; v++)
            if (graph[u][v] && mstSet[v] == 0 && graph[u][v] < key[v])
                parent[v] = u, key[v] = graph[u][v];
    }

    // Print the constructed MST
    printMST(parent, V, graph, V);
}

int main() {
    int V, E;
    printf("Enter the number of vertices and edges: ");
    scanf("%d %d", &V, &E);

    // Create the graph as an adjacency matrix
    int graph[V_MAX][V_MAX];
    for (int i = 0; i < V; i++) {
        for (int j = 0; j < V; j++) {
```

```
            graph[i][j] = 0; // Initialize the graph with 0s
        }
    }

    // Prompt the user to enter the source vertex, destination vertex, and weight for each edge
    printf("Enter the source vertex, destination vertex, and weight for each edge:\n");
    for (int i = 0; i < E; i++) {
        int source, dest, weight;
        scanf("%d %d %d", &source, &dest, &weight);
        graph[source][dest] = weight;
        graph[dest][source] = weight; // Since the graph is undirected
    }

    // Print the MST using Prim's algorithm
    primMST(graph, V);

    return 0;
}
```

OUTPUT:

```
student@lenovo-ThinkCentre-M900:~$ gedit 2.c
student@lenovo-ThinkCentre-M900:~$ gcc 2.c
student@lenovo-ThinkCentre-M900:~$ ./a.out
Enter the number of vertices and edges: 5
7
Enter the source vertex, destination vertex, and weight for each edge:
0 1 2
0 3 6
1 2 3
1 3 8
1 4 5
2 4 7
3 4 9
Edge   Weight
0 - 1    2
1 - 2    3
0 - 3    6
1 - 4    5
```

Program 3

3.a. Design and implement C Program to solve All-Pairs Shortest Paths problem using Floyd's algorithm.

PROGRAM:

```
#include<stdio.h>
  int min(int,int);
void floyds(int p[10][10],int n) {
     int i,j,k;
     for (k=1;k<=n;k++)
       for  (i=1;i<=n;i++)
       for  (j=1;j<=n;j++)
       if(i==j)
         p[i][j]=0;                    else
         p[i][j]=min(p[i][j],p[i][k]+p[k][j]);
}
int min(int a,int b) {
     if(a<b)
     return(a); else
     return(b);
}
void main() {
     int p[10][10],w,n,e,u,v,i,j;

     printf("\n Enter the number of vertices:");
     scanf("%d",&n);
     printf("\n Enter the number of edges:\n");
     scanf("%d",&e);
     for (i=1;i<=n;i++) {
            for (j=1;j<=n;j++)
              p[i][j]=999;
     }
```

```
    for (i=1;i<=e;i++) {
        printf("\n Enter the end vertices of edge%d with its weight \n",i);
        scanf("%d%d%d",&u,&v,&w);
        p[u][v]=w;
    }
    printf("\n Matrix of input data:\n");
    for (i=1;i<=n;i++) {
        for (j=1;j<=n;j++)
          printf("%d \t",p[i][j]);
        printf("\n");
    }
    floyds(p,n);
    printf("\n Transitive closure:\n");
    for (i=1;i<=n;i++) {
        for (j=1;j<=n;j++)
          printf("%d \t",p[i][j]);
        printf("\n");
    }
    printf("\n The shortest paths are:\n");
    for (i=1;i<=n;i++)
      for (j=1;j<=n;j++) {
        if(i!=j)
           printf("\n <%d,%d>=%d",i,j,p[i][j]);
    }

}
```

OUTPUT:

```
 Enter the number of vertices:4
 Enter the number of edges:
5
```

Enter the end vertices of edge1 with its weight

1 3 3

Enter the end vertices of edge2 with its weight

2 1 2

Enter the end vertices of edge3 with its weight

3 2 7

Enter the end vertices of edge4 with its weight

3 4 1

Enter the end vertices of edge5 with its weight

4 1 6

Matrix of input data:

999	999	3	999
2	999	999	999
999	7	999	1
6	999	999	999

Transitive closure:

0	10	3	4
2	0	5	6
7	7	0	1
6	16	9	0

The shortest paths are:

<1,2>=10

<1,3>=3

<1,4>=4

<2,1>=2

<2,3>=5

<2,4>=6

<3,1>=7

<3,2>=7

<3,4>=1

<4,1>=6

<4,2>=16

3b.Design and implement C Program to find the transitive closure using Warshal's algorithm.

PROGRAM:

```
#include<stdio.h>
#include<math.h>
int max(int, int);
void warshal(int p[10][10], int n) {
    int i, j, k;
    for (k = 1; k <= n; k++)
        for (i = 1; i <= n; i++)
            for (j = 1; j <= n; j++)
                p[i][j] = max(p[i][j], p[i][k] && p[k][j]);
}

int max(int a, int b) {

    ;

    if (a > b)
        return (a);
    else
        return (b);
}

void main() {
    int p[10][10] = { 0 }, n, e, u, v, i, j;
```

```
    printf("\n Enter the number of vertices:");
    scanf("%d", &n);
    printf("\n Enter the number of edges:");
    scanf("%d", &e);
    for (i = 1; i <= e; i++) {
        printf("\n Enter the end vertices of edge %d:", i);
        scanf("%d%d", &u, &v);
        p[u][v] = 1;
    }
    printf("\n Matrix of input data: \n");
    for (i = 1; i <= n; i++) {
        for (j = 1; j <= n; j++)
            printf("%d\t", p[i][j]);
        printf("\n");
    }
    warshal(p, n);
    printf("\n Transitive closure: \n");
    for (i = 1; i <= n; i++) {
        for (j = 1; j <= n; j++)
            printf("%d\t", p[i][j]);
        printf("\n");
    }
     }
```

OUTPUT:

```
gedit 3b.c
gcc 3b.c
./a.out
 Enter the number of vertices:5
 Enter the number of edges:11

 Enter the end vertices of edge 1:1 1
```

Enter the end vertices of edge 2:1 4

Enter the end vertices of edge 3:3 2

Enter the end vertices of edge 4:3 3

Enter the end vertices of edge 5:3 4

Enter the end vertices of edge 6:4 2

Enter the end vertices of edge 7:4 4

Enter the end vertices of edge 8:5 2

Enter the end vertices of edge 9:5 3

Enter the end vertices of edge 10:5 4

Enter the end vertices of edge 11:5 5

Matrix of input data:

1	0	0	1	0
0	0	0	0	0
0	1	1	1	0
0	1	0	1	0
0	1	1	1	1

Transitive closure:

1	1	0	1	0
0	0	0	0	0
0	1	1	1	0
0	1	0	1	0
0	1	1	1	1

Program 4

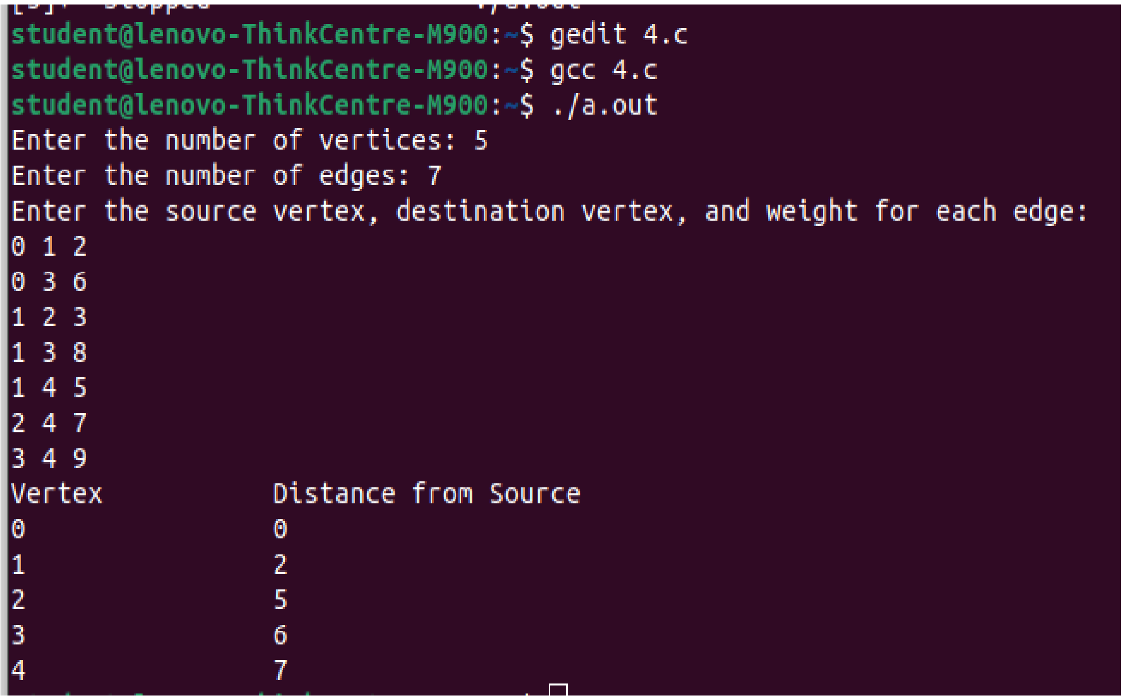
4. Design and implement C Program to find shortest paths from a given vertex in a weighted connected graph to other vertices using Dijkstra's algorithm.

```
#include <stdio.h>

#include <stdbool.h>

#include <limits.h>


#define MAX_VERTICES 10  // Maximum number of vertices

#define INF INT_MAX


// A function to find the vertex with the minimum distance value, from the set of vertices not yet
included in the shortest path tree

int minDistance(int dist[], bool sptSet[], int V) {

    int min = INF, min_index;

    for (int v = 0; v < V; v++)

        if (sptSet[v] == false && dist[v] <= min)

            min = dist[v], min_index = v;

    return min_index;

}


// A utility function to print the constructed distance array

void printSolution(int dist[], int V) {

    printf("Vertex \t\t Distance from Source\n");

    for (int i = 0; i < V; i++)

        printf("%d \t\t %d\n", i, dist[i]);

}

// Dijkstra's algorithm for adjacency matrix representation of the graph

void dijkstra(int graph[MAX_VERTICES][MAX_VERTICES], int src, int V) {

    int dist[MAX_VERTICES];  // The output array. dist[i] will hold the shortest distance from src to i

    bool sptSet[MAX_VERTICES];  // sptSet[i] will be true if vertex i is included in the shortest path
tree


    // Initialize all distances as INFINITE and sptSet[] as false
```

```
    for (int i = 0; i < V; i++)
        dist[i] = INF, sptSet[i] = false;

    dist[src] = 0;

    // Find shortest path for all vertices
    for (int count = 0; count < V - 1; count++) {
        int u = minDistance(dist, sptSet, V);
        sptSet[u] = true;
        for (int v = 0; v < V; v++)
            if (!sptSet[v] && graph[u][v] && dist[u] != INF && dist[u] + graph[u][v] < dist[v])
                dist[v] = dist[u] + graph[u][v];
    }
    printSolution(dist,  V);
}
// Driver code
int main() {
    int V, E;
    printf("Enter the number of vertices: ");
    scanf("%d", &V);
    printf("Enter the number of edges: ");
    scanf("%d", &E);

    int graph[MAX_VERTICES][MAX_VERTICES] = {{0}};

    printf("Enter the source vertex, destination vertex, and weight for each edge:\n");
    for (int i = 0; i < E; i++) {
        int source, dest, weight;
        scanf("%d %d %d", &source, &dest, &weight);
        graph[source][dest] = weight;
        graph[dest][source] = weight; // Assuming undirected graph
    }
```

```
    dijkstra(graph, 0, V);

    return 0;

}
```

OUTPUT:



```
student@lenovo-ThinkCentre-M900:~$ gedit 4.c
student@lenovo-ThinkCentre-M900:~$ gcc 4.c
student@lenovo-ThinkCentre-M900:~$ ./a.out
Enter the number of vertices: 5
Enter the number of edges: 7
Enter the source vertex, destination vertex, and weight for each edge:
0 1 2
0 3 6
1 2 3
1 3 8
1 4 5
2 4 7
3 4 9
Vertex           Distance from Source
0                0
1                2
2                5
3                6
4                7
```

Program 5

Design and implement C Program to obtain the Topological ordering of vertices in a given digraph.

```
#include <stdio.h>

#include <stdlib.h>


#define MAX_VERTICES 100


// Structure to represent a graph

typedef struct {

    int V;

    int** adjMatrix;

} Graph;


// Function to create a new graph

Graph* createGraph(int V) {

    Graph* graph = (Graph*)malloc(sizeof(Graph));

    graph->V = V;

    graph->adjMatrix = (int**)calloc(V, sizeof(int*));

    for (int i = 0; i < V; i++) graph->adjMatrix[i] = (int*)calloc(V, sizeof(int));

    return graph;

}


// Function to add an edge to the graph

void addEdge(Graph* graph, int src, int dest) {

    graph->adjMatrix[src][dest] = 1;

}


// Function to perform topological sorting

void topologicalSort(Graph* graph) {

    int V = graph->V, inDegree[MAX_VERTICES] = {0}, queue[MAX_VERTICES], front = 0, rear =
-1;
```

```
    for (int i = 0; i < V; i++)
        for (int j = 0; j < V; j++)
            if (graph->adjMatrix[i][j] == 1) inDegree[j]++;

    for (int i = 0; i < V; i++) if (inDegree[i] == 0) queue[++rear] = i;

    printf("Topological ordering of vertices: ");
    while (front <= rear) {
        int vertex = queue[front++];
        printf("%d ", vertex);
        for (int i = 0; i < V; i++) if (graph->adjMatrix[vertex][i] == 1 && --inDegree[i] == 0)
queue[++rear] = i;
    }
    printf("\n");
}

// Driver code
int main() {
    int V, E;
    printf("Enter the number of vertices: ");
    scanf("%d", &V);
    Graph* graph = createGraph(V);
    printf("Enter the number of edges: ");
    scanf("%d", &E);
    printf("Enter the edges (source vertex, destination vertex):\n");
    for (int i = 0, src, dest; i < E; i++) {
        scanf("%d %d", &src, &dest);
        addEdge(graph, src, dest);
    }
    topologicalSort(graph);
    return 0;
}
```

OUTPUT:

```
student@lenovo-ThinkCentre-M900:~$ gcc 5.c
student@lenovo-ThinkCentre-M900:~$ ./a.out
Enter the number of vertices: 7
Enter the number of edges: 8
Enter the edges (source vertex, destination vertex):
0 1
0 2
1 3
2 3
3 4
3 5
4 6
5 6
Topological ordering of vertices: 0 1 2 3 4 5 6
```

Program 6

6. Design and implement C Program to solve 0/1 Knapsack problem using Dynamic Programming method.

```
#include <stdio.h>


// Function to find maximum of two integers
int max(int a, int b) {
    return (a > b) ? a : b;
}
// Function to solve 0/1 Knapsack problem
int knapsack(int W, int wt[], int val[], int n) {
    int i, w;
    int K[n + 1][W + 1];

    // Build table K[][] in bottom-up manner
    for (i = 0; i <= n; i++) {
        for (w = 0; w <= W; w++) {
            if (i == 0 || w == 0)
                K[i][w] = 0;
            else if (wt[i - 1] <= w)
                K[i][w] = max(val[i - 1] + K[i - 1][w - wt[i - 1]], K[i - 1][w]);
            else
                K[i][w] = K[i - 1][w];
        }
    }

    // K[n][W] contains the maximum value that can be put in a knapsack of capacity W
    return K[n][W];
}

int main() {
    int val[100], wt[100]; // Arrays to store values and weights
```

```
    int W, n; // Knapsack capacity and number of items
    printf("Enter the number of items: ");
    scanf("%d", &n);
    printf("Enter the values and weights of %d items:\n", n);
    for (int i = 0; i < n; i++) {
        printf("Enter value and weight for item %d: ", i + 1);
        scanf("%d %d", &val[i], &wt[i]);
    }

    printf("Enter the knapsack capacity: ");
    scanf("%d", &W);
    printf("Maximum value that can be obtained: %d\n", knapsack(W, wt, val, n));
    return 0;
}
```

OUTPUT:

```
student@lenovo-ThinkCentre-M900:~$ gcc 6.c
student@lenovo-ThinkCentre-M900:~$ ./a.out
Enter the number of items: 4
Enter the values and weights of 4 items:
Enter value and weight for item 1: 42 7
Enter value and weight for item 2: 12 3
Enter value and weight for item 3: 40 4
Enter value and weight for item 4: 25 5
Enter the knapsack capacity: 10
Maximum value that can be obtained: 65
```

Program 7

7. Design and implement C Program to solve discrete Knapsack and continuous Knapsack problems using greedy approximation method.

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

// Structure to represent items
struct Item {
    int value;
    int weight;
    double ratio; // Value-to-weight ratio for sorting
};

// Comparison function for sorting items based on ratio in descending order
int compare(const void *a, const void *b) {
    struct Item *item1 = (struct Item *)a;
    struct Item *item2 = (struct Item *)b;
    double ratio1 = item1->ratio;
    double ratio2 = item2->ratio;
    if (ratio1 > ratio2) return -1;
    else if (ratio1 < ratio2) return 1;
    else return 0;
}

// Function to solve discrete Knapsack problem
void discreteKnapsack(struct Item items[], int n, int capacity) {
    int i, j;
    int dp[n + 1][capacity + 1];

    // Initialize the DP table
    for (i = 0; i <= n; i++) {
        for (j = 0; j <= capacity; j++) {
            if (i == 0 || j == 0)
                dp[i][j] = 0;
            else if (items[i - 1].weight <= j)
                dp[i][j] = (items[i - 1].value + dp[i - 1][j - items[i - 1].weight] > dp[i - 1][j]) ?
                           (items[i - 1].value + dp[i - 1][j - items[i - 1].weight]) :
                           dp[i - 1][j];
            else
                dp[i][j] = dp[i - 1][j];
        }
    }

    printf("Total value obtained for discrete knapsack: %d\n", dp[n][capacity]);
}

// Function to solve continuous Knapsack problem
void continuousKnapsack(struct Item items[], int n, int capacity) {
    int i;
    double totalValue = 0.0;
    int remainingCapacity = capacity;
```

```
    for (i = 0; i < n; i++) {
        if (remainingCapacity >= items[i].weight) {
            totalValue += items[i].value;
            remainingCapacity -= items[i].weight;
        } else {
            totalValue += (double)remainingCapacity / items[i].weight * items[i].value;
            break;
        }
    }

    printf("Total value obtained for continuous knapsack: %.2lf\n", totalValue);
}

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

    struct Item items[n];

    printf("Enter the capacity of the knapsack: ");
    scanf("%d", &capacity);

    printf("Enter the value and weight of each item:\n");
    for (i = 0; i < n; i++) {
        scanf("%d %d", &items[i].value, &items[i].weight);
        items[i].ratio = (double)items[i].value / items[i].weight;
    }

    // Sort items based on value-to-weight ratio
    qsort(items, n, sizeof(struct Item), compare);

    discreteKnapsack(items, n, capacity);
    continuousKnapsack(items, n, capacity);

    return 0;
}
```

OUTPUT:

```
student@lenovo-ThinkCentre-M900:~$ ./a.out
Enter the number of items: 4
Enter the capacity of the knapsack: 10
Enter the value and weight of each item:
42 7
12 3
40 4
25 5
Total value obtained for discrete knapsack: 65
Total value obtained for continuous knapsack: 76.00
```

Program 8

Design and implement C Program to find a subset of a given set S = {sl , s2,. ...,sn} of n positive integers whose sum is equal to a given positive integer d.

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


#define MAX_SIZE 100


// Function to find subset with given sum
void subsetSum(int set[], int subset[], int n, int subSize, int total, int nodeCount, int sum) {
    if (total == sum) {
        // Print the subset
        printf("Subset found: { ");
        for (int i = 0; i < subSize; i++) {
            printf("%d ", subset[i]);
        }
        printf("}\n");
        return;
    } else {
        // Check the sum of the remaining elements
        for (int i = nodeCount; i < n; i++) {
            subset[subSize] = set[i];
            subsetSum(set, subset, n, subSize + 1, total + set[i], i + 1, sum);
        }
    }
}
int main() {
    int set[MAX_SIZE];
    int subset[MAX_SIZE];
    int n, sum;
```

```
    // Input the number of elements in the set
    printf("Enter the number of elements in the set: ");
    scanf("%d", &n);

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

    // Input the target sum
    printf("Enter the sum to find subset for: ");
    scanf("%d", &sum);

    printf("Subsets with sum %d:\n", sum);
    subsetSum(set, subset, n, 0, 0, 0, sum);

    return 0;
}
```

OUTPUT:

```
student@lenovo-ThinkCentre-M900:~$ gcc program8.c
student@lenovo-ThinkCentre-M900:~$ ./a.out
Enter the number of elements in the set: 5
Enter the elements of the set:
2
4
6
8
10
Enter the sum to find subset for: 10
Subsets with sum 10:
Subset found: { 2 8 }
Subset found: { 4 6 }
Subset found: { 10 }
```

Program 9

Design and implement C Program to sort a given set of n integer elements using Selection Sort method and compute its time complexity. Run the program for varied values of n> 5000 and record the time taken to sort. Plot a graph of the time taken versus n. The elements can be read from a file or can be generated using the random number generator.

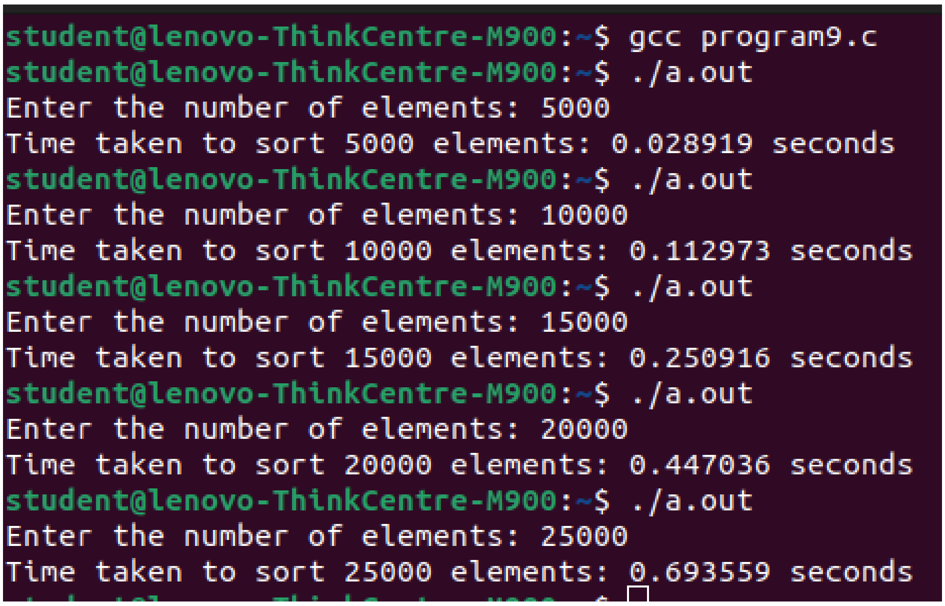
PROGRAM:

```
#include  <stdio.h>
#include <stdlib.h>
#include <time.h>
// Function to perform Selection Sort
void selectionSort(int arr[], int n) {
    int  i,  j,  minIndex,  temp;
    for (i = 0; i < n - 1; i++) {
        minIndex = i;
        for (j = i + 1; j < n; j++) {
            if (arr[j] < arr[minIndex]) {
                minIndex = j;
            }
        }
        // Swap the found minimum element with the first element
        temp = arr[minIndex];
        arr[minIndex] = arr[i];
        arr[i] = temp;
    }
}
int main() {
    int n, i;
    clock_t start, end;
    double cpu_time_used;

    printf("Enter the number of elements (n): ");
```

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

    if (n < 5000) {
        printf("Please enter a value of n greater than 5000.\n");
        return 1;
    }
    int *arr = (int *)malloc(n * sizeof(int));
    if (arr == NULL) {
        printf("Memory allocation failed.\n");
        return 1;
    }

    // Generate n random numbers
    srand(time(NULL));
    // printf("Randomly generated array: ");
    for (i = 0; i < n; i++) {
        arr[i] = rand() % 10000; // Generating random numbers between 0 to 9999
        // printf("%d ", arr[i]);
    }
    // printf("\n");

    // Record the starting time
    start = clock();

    // Perform Selection Sort
    selectionSort(arr, n);

    // Record the ending time
    end = clock();

    // Calculate the time taken
    cpu_time_used = ((double)(end - start)) / CLOCKS_PER_SEC;
```

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

    printf("Time taken for sorting: %lf seconds\n", cpu_time_used);

    free(arr); // Free dynamically allocated memory
    return 0;
}
```

OUTPUT:



```
student@lenovo-ThinkCentre-M900:~$ gcc program9.c
student@lenovo-ThinkCentre-M900:~$ ./a.out
Enter the number of elements: 5000
Time taken to sort 5000 elements: 0.028919 seconds
student@lenovo-ThinkCentre-M900:~$ ./a.out
Enter the number of elements: 10000
Time taken to sort 10000 elements: 0.112973 seconds
student@lenovo-ThinkCentre-M900:~$ ./a.out
Enter the number of elements: 15000
Time taken to sort 15000 elements: 0.250916 seconds
student@lenovo-ThinkCentre-M900:~$ ./a.out
Enter the number of elements: 20000
Time taken to sort 20000 elements: 0.447036 seconds
student@lenovo-ThinkCentre-M900:~$ ./a.out
Enter the number of elements: 25000
Time taken to sort 25000 elements: 0.693559 seconds
```

Program 10

Design and implement C Program to sort a given set of n integer elements using Quick Sort method and compute its time complexity. Run the program for varied values of n> 5000 and record the time taken to sort. Plot a graph of the time taken versus n. The elements can be read from a file or can be generated using the random number generator.

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


// Function to partition the array using Hoare's algorithm
int hoarePartition(int arr[], int l, int r) {
    int pivot = arr[l]; // Pivot is the first element
    int i = l - 1, j = r + 1;

    while (1) {
        do {
            i++;
        } while (arr[i] < pivot);

        do {
            j--;
        } while (arr[j] > pivot);

        if (i >= j)
            return j;

        // Swap arr[i] and arr[j]
        int temp = arr[i];
        arr[i] = arr[j];
        arr[j] = temp;
```

```
    }
}

// Function to perform quicksort using Hoare's partition
void quickSort(int arr[], int low, int high) {
    if (low < high) {
        int pi = hoarePartition(arr, low, high);
        quickSort(arr, low, pi);
        quickSort(arr, pi + 1, high);
    }
}

int main() {
    int n, i;
    clock_t start, end;
    double cpu_time_used;

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

    if (n < 5000) {
        printf("Please enter a value of n greater than 5000.\n");
        return 1;
    }

    int *arr = (int *)malloc(n * sizeof(int));
    if (arr == NULL) {
        printf("Memory allocation failed.\n");
        return 1;
    }

    srand(time(NULL));
```

```
    for (i = 0; i < n; i++) {
        arr[i] = rand() % 10000;
    }

    start = clock();
    quickSort(arr, 0, n - 1);
    end = clock();

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

    printf("Time taken for sorting: %lf seconds\n", cpu_time_used);

    free(arr);
    return 0;
}
```

OUTPUT:

```
student@lenovo-ThinkCentre-M900:~$ gcc 10.c
student@lenovo-ThinkCentre-M900:~$ ./a.out
Enter the number of elements: 5000
Time taken to sort 5000 elements: 0.000557 seconds
student@lenovo-ThinkCentre-M900:~$ gcc 10.c
student@lenovo-ThinkCentre-M900:~$ ./a.out
Enter the number of elements: 10000
Time taken to sort 10000 elements: 0.001171 seconds
student@lenovo-ThinkCentre-M900:~$ gcc 10.c
student@lenovo-ThinkCentre-M900:~$ ./a.out
Enter the number of elements: 15000
Time taken to sort 15000 elements: 0.001912 seconds
student@lenovo-ThinkCentre-M900:~$ gcc 10.c
student@lenovo-ThinkCentre-M900:~$ ./a.out
Enter the number of elements: 20000
Time taken to sort 20000 elements: 0.002697 seconds
student@lenovo-ThinkCentre-M900:~$ gcc 10.c
student@lenovo-ThinkCentre-M900:~$ ./a.out
Enter the number of elements: 25000
Time taken to sort 25000 elements: 0.003862 seconds
```

Program 11

Design and implement C Program to sort a given set of n integer elements using Merge Sort method and compute its time complexity. Run the program for varied values of n> 5000, and record the time taken to sort. Plot a graph of the time taken versus n. The elements can be read from a file or can be generated using the random number generator.

PROGRAM:

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

// Merge two subarrays of arr[].
// First subarray is arr[l..m]
// Second subarray is arr[m+1..r]
void merge(int arr[], int l, int m, int r) {
    int i, j, k;
    int n1 = m - l + 1;
    int n2 = r - m;

    // Create temporary arrays
    int L[n1], R[n2];

    // Copy data to temporary arrays L[] and R[]
    for (i = 0; i < n1; i++)
        L[i] = arr[l + i];
    for (j = 0; j < n2; j++)
        R[j] = arr[m + 1 + j];

    // Merge the temporary arrays back into arr[l..r]
    i = 0;
```

```
    j = 0;
    k = l;
    while (i < n1 && j < n2) {
        if (L[i] <= R[j]) {
            arr[k] = L[i];
            i++;
        } else {
            arr[k] = R[j];
            j++;
        }
        k++;
    }

    // Copy the remaining elements of L[], if any
    while (i < n1) {
        arr[k] = L[i];
        i++;
        k++;
    }

    // Copy the remaining elements of R[], if any
    while (j < n2) {
        arr[k] = R[j];
        j++;
        k++;
    }
}

// Merge Sort function
void mergeSort(int arr[], int l, int r) {
    if (l < r) {
        // Same as (l+r)/2, but avoids overflow for large l and r
```

```
        int m = l + (r - l) / 2;

        // Sort first and second halves
        mergeSort(arr, l, m);
        mergeSort(arr, m + 1, r);

        // Merge the sorted halves
        merge(arr, l, m, r);
    }
}

int main() {
    int n, i;
    clock_t start, end;
    double cpu_time_used;

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

    if (n < 5000) {
        printf("Please enter a value of n greater than 5000.\n");
        return 1;
    }

    int *arr = (int *)malloc(n * sizeof(int));
    if (arr == NULL) {
        printf("Memory allocation failed.\n");
        return 1;
    }

    // Generate n random numbers
    srand(time(NULL));
```

```
    // printf("Randomly generated array: ");
    for (i = 0; i < n; i++) {
        arr[i] = rand() % 10000; // Generating random numbers between 0 to 9999
        // printf("%d ", arr[i]);
    }
    // printf("\n");

    // Record the starting time
    start = clock();

    // Perform Merge Sort
    mergeSort(arr, 0, n - 1);

    // Record the ending time
    end = clock();

    // Calculate the time taken
    cpu_time_used = ((double)(end - start)) / CLOCKS_PER_SEC;

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

    printf("Time taken for sorting: %lf seconds\n", cpu_time_used);

    free(arr); // Free dynamically allocated memory
    return 0;
}
```

OUTPUT:

```
student@lenovo-ThinkCentre-M900:~$ gcc 11.c
student@lenovo-ThinkCentre-M900:~$ ./a.out
Enter the number of elements: 5000
Time taken to sort 5000 elements: 0.000691 seconds
student@lenovo-ThinkCentre-M900:~$ gcc 11.c
student@lenovo-ThinkCentre-M900:~$ ./a.out
Enter the number of elements: 10000
Time taken to sort 10000 elements: 0.001521 seconds
student@lenovo-ThinkCentre-M900:~$ gcc 11.c
student@lenovo-ThinkCentre-M900:~$ ./a.out
Enter the number of elements: 15000
Time taken to sort 15000 elements: 0.002262 seconds
student@lenovo-ThinkCentre-M900:~$ gcc 11.c
student@lenovo-ThinkCentre-M900:~$ ./a.out
Enter the number of elements: 20000
Time taken to sort 20000 elements: 0.003134 seconds
student@lenovo-ThinkCentre-M900:~$ gcc 11.c
student@lenovo-ThinkCentre-M900:~$ ./a.out
Enter the number of elements: 25000
Time taken to sort 25000 elements: 0.003956 seconds
```

Program 12

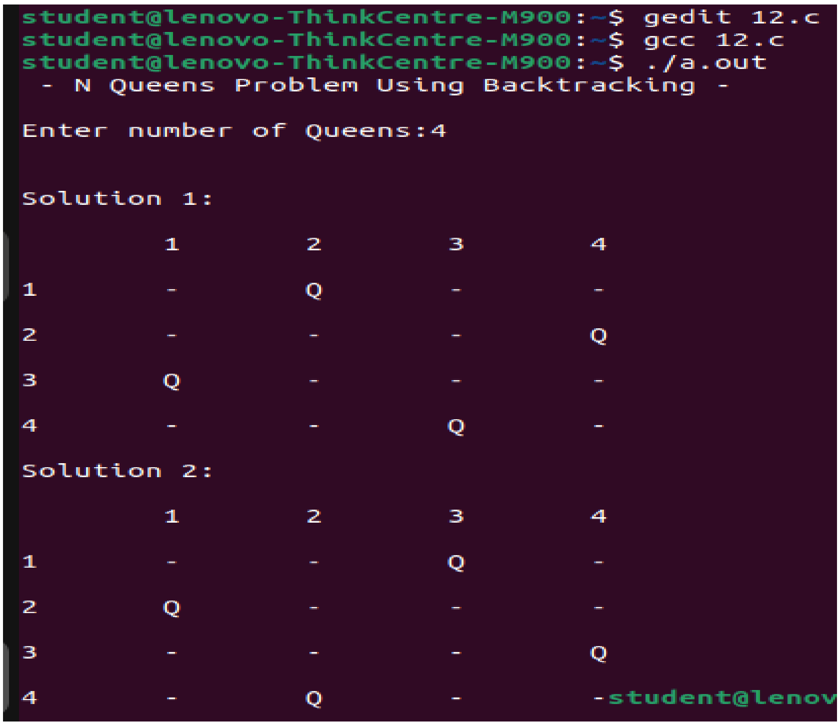
Design and implement C/C++ Program for N Queen's problem using Backtracking.

```
#include<stdio.h>
#include<math.h>
#include<stdlib.h>
int board[20],count;

int main()
{
int n,i,j;
void queen(int row,int n);

printf(" - N Queens Problem Using Backtracking -");
printf("\n\nEnter number of Queens:");
scanf("%d",&n);
queen(1,n);
return 0;
}

//function for printing the solution
void print(int n)
{
int i,j;
printf("\n\nSolution %d:\n\n",++count);

for(i=1;i<=n;++i)
  printf("\t%d",i);

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

```
  printf("\n\n%d",i);
  for(j=1;j<=n;++j) //for nxn board
  {
   if(board[i]==j)
    printf("\tQ"); //queen at i,j position
   else
    printf("\t-"); //empty slot
  }
}
}

/*funtion to check conflicts
If no conflict for desired postion returns 1 otherwise returns 0*/
int place(int row,int column)
{
int i;
for(i=1;i<=row-1;++i)
{
  //checking column and digonal conflicts
  if(board[i]==column)
   return 0;
  else
   if(abs(board[i]-column)==abs(i-row))
    return 0;
}

return 1; //no conflicts
}

//function to check for proper positioning of queen
void queen(int row,int n)
{
```

```
int column;
for(column=1;column<=n;++column)
{
  if(place(row,column))
  {
   board[row]=column; //no conflicts so place queen
   if(row==n) //dead end
    print(n); //printing the board configuration
   else //try queen with next position
   queen(row+1,n);
  }
}
}
```

OUTPUT:



```
student@lenovo-ThinkCentre-M900:~$ gedit 12.c
student@lenovo-ThinkCentre-M900:~$ gcc 12.c
student@lenovo-ThinkCentre-M900:~$ ./a.out
 - N Queens Problem Using Backtracking -

Enter number of Queens:4


Solution 1:

        1       2       3       4

1       -       Q       -       -

2       -       -       -       Q

3       Q       -       -       -

4       -       -       Q       -

Solution 2:

        1       2       3       4

1       -       -       Q       -

2       Q       -       -       -

3       -       -       -       Q

4       -       Q       -       -student@lenov
```