VISVESVARAYA TECHNOLOGICAL UNIVERSITY

"JnanaSangama", Belgaum -590014, Karnataka.

LAB REPORT

on

Analysis and Design of Algorithms

(22CS4PCADA)

Submitted by

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in partial fulfillment for the award of the degree of

BACHELOR OF ENGINEERING

in

COMPUTER SCIENCE AND ENGINEERING

B.M.S. COLLEGE OF ENGINEERING

(Autonomous Institution under VTU)

BENGALURU-560019

May-2023 to July-2023

B. M. S. College of Engineering,

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Department of Computer Science and Engineering

CERTIFICATE

This is to certify that the Lab work entitled "**Analysis and Design of Algorithms**" carried out by **Puneeth Kumar HT(1BM22CS414),** who is bonafide student of **B.M.S. College of Engineering.** It is in partial fulfillment for the award of **Bachelor of Engineering in Computer Science and Engineering** of the Visvesvaraya Technological University, Belgaum during the academic semester May-2023 to July-2023. The Lab report has been approved as it satisfies the academic requirements in respect of **Analysis and Design of Algorithms (22CS4PCADA)** work prescribed for the said degree.

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Index Sheet

Course Outcome

CO1	Analyze time complexity of Recursive and Non-recursive algorithms using asymptotic notations.
CO2	Apply various design techniques for the given problem.
CO3	Apply the knowledge of complexity classes P, NP, and NP-Complete and prove certain problems are NP-Complete
CO4	Design efficient algorithms and conduct practical experiments to solve problems.

1. I) Breadth First Search

Aim: To print all the nodes reachable from a given starting node in a digraph using BFS method

Code:

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

int main(void)
{
   printf("Enter the number of vertices: ");
   int n;
   scanf("%d", &n);
   int i, j;
   int **adjMatrix = (int **)malloc(n * sizeof(int *));
   for (i = 0; i < n; i++)
   {
      adjMatrix[i] = (int *)malloc(n * sizeof(int));
      for (j = 0; j < n; j++)
      {
         adjMatrix[i][j] = 0;
      }
   }

   printf("Enter the adjacency matrix:\n");
   for (i = 0; i < n; i++)
   {
      for (j = 0; j < n; j++)
```

```
    {
        scanf("%d", &adjMatrix[i][j]);
    }
}

printf("Enter the starting vertex: ");
int src;
scanf("%d", &src);

printf("Breadth First Traversal is as (starting from vertex %d):\n", src);
bool visited[n];
for (i = 0; i < n; i++)
{
    visited[i] = false;
}

int queue[n];
int front = 0, rear = 0;

visited[src] = true;
queue[rear++] = src;

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

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

```
            if (adjMatrix[currentVertex][adjacent] && !visited[adjacent])
            {
                visited[adjacent] = true;
                queue[rear++] = adjacent;
            }
        }
    }

    for (i = 0; i < n; i++)
    {
        free(adjMatrix[i]);
    }
    free(adjMatrix);
}
```

Output:

```
PS D:\codes\ADA Lab> cd "d:\codes\ADA Lab\" ; if ($?) { gcc BFS.c -o BFS } ; if ($?) { .\BFS }
Enter the number of vertices: 6
Enter the adjacency matrix:
0 1 1 1 0 0
1 0 0 1 1 0
1 0 0 1 0 1
1 1 1 0 1 1
0 1 0 1 0 1
0 0 1 1 1 0
Enter the starting vertex: 0
Breadth First Traversal is as (starting from vertex 0):
0 1 2 3 4 5
PS D:\codes\ADA Lab>
```

1. II) Depth First Search

Aim: To check whether a given graph is connected or not using DFS method

Code:

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

void DFS(int vertex, int **adjMatrix, bool *visited, int n)
{
    printf("%d ", vertex);
    visited[vertex] = true;
    for (int adjacent = 0; adjacent < n; adjacent++)
    {
        if (adjMatrix[vertex][adjacent] && !visited[adjacent])
        {
            DFS(adjacent, adjMatrix, visited, n);
        }
    }
}

int main(void)
{
    printf("Enter the number of vertices: ");
    int n;
    scanf("%d", &n);
    int i, j;
    int **adjMatrix = (int **)malloc(n * sizeof(int *));
```

```
for (i = 0; i < n; i++)
{
   adjMatrix[i] = (int *)malloc(n * sizeof(int));
   for (j = 0; j < n; j++)
   {
      adjMatrix[i][j] = 0;
   }
}

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

printf("Enter the starting vertex: ");
int src;
scanf("%d", &src);

printf("Depth First Traversal is as (starting from vertex %d):\n", src);
bool visited[n];
for (i = 0; i < n; i++)
{
   visited[i] = false;
}
```

```
    DFS(src, adjMatrix, visited, n);

    for (i = 0; i < n; i++)
    {
        free(adjMatrix[i]);
    }
    free(adjMatrix);
}
```

Output:

```
PS D:\codes\ADA Lab> cd "d:\codes\ADA Lab\" ; if ($?) { gcc DFS.c -o DFS } ; if ($?) { .\DFS }
Enter the number of vertices: 5
Enter the adjacency matrix:
0 1 1 1 1
1 0 0 0 0
1 0 0 0 0
1 0 0 0 0
1 0 0 0 0
Enter the starting vertex: 1
Depth First Traversal is as (starting from vertex 1):
1 0 2 3 4
```

2.Topological Sorting

Aim: To obtain the Topological ordering of vertices in a given digraph

Code:

```
#include <stdio.h>
int main()
{
   int n;
   printf("Enter the no of vertices: ");
   scanf("%d", &n);
   int a[n][n], indeg[n], flag[n];

   int i, j, k, count = 0;
   printf("Enter the adjacency matrix:\n");
   for (i = 0; i < n; i++)
   {
      for (j = 0; j < n; j++)
         scanf("%d", &a[i][j]);
   }

   for (i = 0; i < n; i++)
   {
      indeg[i] = 0;
      flag[i] = 0;
   }

   for (i = 0; i < n; i++)
      for (j = 0; j < n; j++)
```

```
            indeg[i] = indeg[i] + a[j][i];
    printf("\nThe topological order is: ");
    while (count < n)
    {
        for (k = 0; k < n; k++)
        {
            if ((indeg[k] == 0) && (flag[k] == 0))
            {
                printf("%d ", (k + 1));
                flag[k] = 1;
            }
            for (i = 0; i < n; i++)
            {
                if (a[i][k] == 1)
                    indeg[k]--;
            }
        }
        count++;
    }
    return 0;
}
```

Output:

```
PS D:\codes\ADA Lab> cd "d:\codes\ADA Lab\" ; if ($?) { gcc TopoSort.c -o TopoSort } ; if ($?) { .\TopoSort }
Enter the no of vertices: 4
Enter the adjacency matrix:
0 1 1 0
0 0 0 1
0 0 0 1
0 0 0 0

The topological order is: 1 2 3 4
```

3.Johnson Trotter algorithm

Aim: To generate permutations of n numbers using Johnson Trotter algorithm

Code:

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

bool LR = true;
bool RL = false;

int search(int a[], int n, int mobile)
{
   for (int i = 0; i < n; i++)
   {
      if (a[i] == mobile)
      {
         return i + 1;
      }
   }
}

int getMobile(int a[], bool dir[], int n)
{
   int i;
   int prev = 0, mobile = 0;

   for (i = 0; i < n; i++)
   {
      if (dir[a[i] - 1] == RL && i != 0)
```

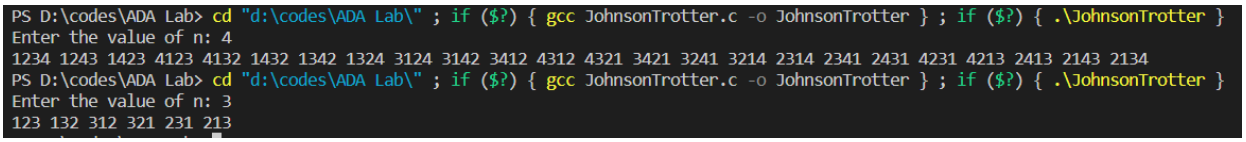
```
        {
            if (a[i] > a[i - 1] && a[i] > prev)
            {
                mobile = a[i];
                prev = mobile;
            }
        }

        if (dir[a[i] - 1] == LR && i != n - 1)
        {
            if (a[i] > a[i + 1] && a[i] > prev)
            {
                mobile = a[i];
                prev = mobile;
            }
        }
    }

    if (mobile == 0 && prev == 0)
        return 0;
    else
        return mobile;
}

int Perm(int a[], bool dir[], int n)
{
    int temp;
    int mobile = getMobile(a, dir, n);
    int pos = search(a, n, mobile);
```

```
if (dir[a[pos - 1] - 1] == RL)
{
   temp = a[pos - 1];
   a[pos - 1] = a[pos - 2];
   a[pos - 2] = temp;
}
else if (dir[a[pos - 1] - 1] == LR)
{
   temp = a[pos];
   a[pos] = a[pos - 1];
   a[pos - 1] = temp;
}

for (int i = 0; i < n; i++)
{
   if (a[i] > mobile)
   {
      if (dir[a[i] - 1] == LR)
         dir[a[i] - 1] = RL;
      else if (dir[a[i] - 1] == RL)
         dir[a[i] - 1] = LR;
   }
}

for (int i = 0; i < n; i++)
{
   printf("%d", a[i]);
}
```

```
    printf(" ");
}

int fact(int n)
{
    int fact = 1;

    for (int i = 1; i <= n; i++)
    {
        fact = fact * i;
    }
    return fact;
}

void perms(int n)
{
    int a[n];
    bool dir[n];

    for (int i = 0; i < n; i++)
    {
        a[i] = i + 1;
        printf("%d", a[i]);
    }
    printf("\n");

    for (int i = 0; i < n; i++)
        dir[i] = RL;
```

```
    for (int i = 1; i < fact(n); i++)
        Perm(a, dir, n);
}

int main(void)
{
    int n;
    printf("Enter the value of n: ");
    scanf("%d", &n);
    perms(n);
}
```

Output:



4.Merge Sort

Aim: To sort a given set of N integer elements using Merge Sort technique, compute its time taken for different values of N and record the time taken to sort

Code:

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


void merge(int arr[], int p, int q, int r)
{
   int n1 = q - p + 1;
   int n2 = r - q;
   int L[n1], M[n2];

   for (int i = 0; i < n1; i++)
      L[i] = arr[p + i];
   for (int j = 0; j < n2; j++)
      M[j] = arr[q + 1 + j];

   int i, j, k;
   i = 0;
   j = 0;
   k = p;

   while (i < n1 && j < n2)
   {
      if (L[i] <= M[j])
      {
```

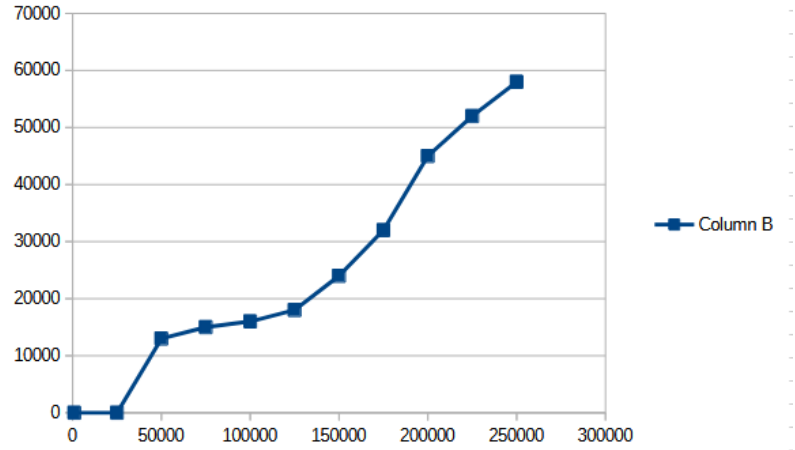
```
            arr[k] = L[i];
            i++;
        }
        else
        {
            arr[k] = M[j];
            j++;
        }
        k++;
    }

    while (i < n1)
    {
        arr[k] = L[i];
        i++;
        k++;
    }

    while (j < n2)
    {
        arr[k] = M[j];
        j++;
        k++;
    }
}

void mergeSort(int arr[], int l, int r)
{
    if (l < r)
```

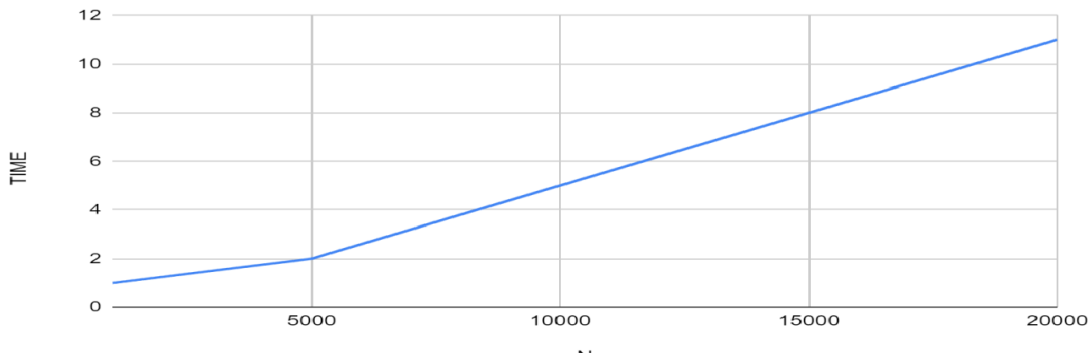
```
    {
        int m = l + (r - l) / 2;

        mergeSort(arr, l, m);
        mergeSort(arr, m + 1, r);

        merge(arr, l, m, r);
    }
}

int main(void)
{
    int n;
    printf("Enter the no of elements: ");
    scanf("%d", &n);
    int arr[n];

    // printf("Enter the elements: ");
    srand(time(0));
    for (int i = 0; i < n; i++)
    {
        arr[i] = rand();
    }

    clock_t st, end;
    st = clock();
    mergeSort(arr, 0, n - 1);
    end = clock();
    double time_taken = (((double)(end - st)) / CLOCKS_PER_SEC);
```

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

    printf("\nTime taken: %lf micro seconds\n", time_taken * 1000000);
}
```

Output with input size vs time graph:

Merge Sort	
Input Size	Time taken (in micro seconds)
1000	0
25000	0
50000	13000
75000	15000
100000	16000
125000	18000
150000	24000
175000	32000
200000	45000
225000	52000
250000	58000





5.Quick Sort

Aim: To sort a given set of N integer elements using Quick Sort technique and compute its time taken

Code:

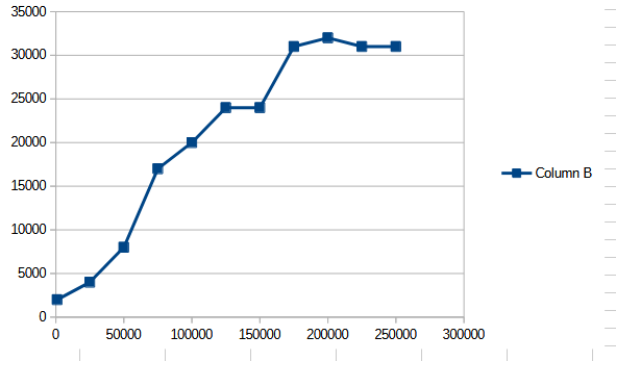
```
#include   <stdio.h>
#include  <stdlib.h>
#include <time.h>


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


int partition(int arr[], int low, int high)
{
   int pivot = arr[high];
   int i = (low - 1);

   for (int j = low; j <= high - 1; j++)
   {
      if (arr[j] < pivot)
      {
         i++;
         swap(&arr[i], &arr[j]);
      }
   }
```

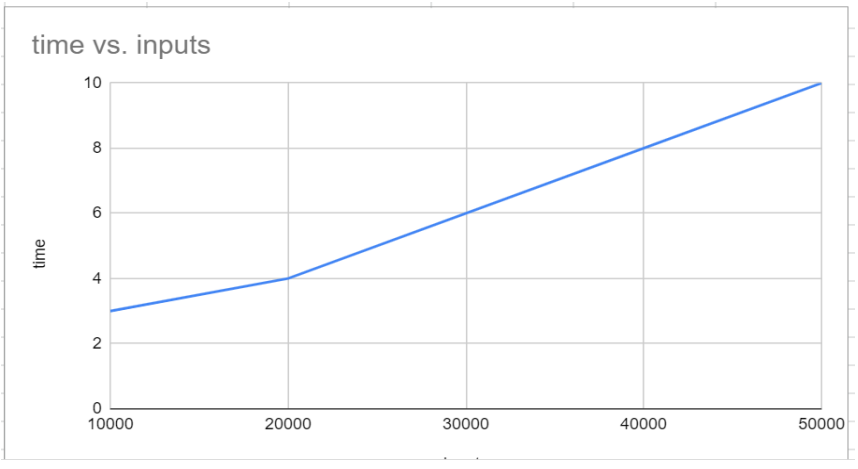
```
    swap(&arr[i + 1], &arr[high]);

    return (i + 1);
}

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

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

int main(void)
{
    int n;
    printf("Enter the no of elements: ");
    scanf("%d", &n);
    int arr[n];

    // printf("Enter the elements: ");
    srand(time(0));
    for (int i = 0; i < n; i++)
    {
        arr[i] = rand();
    }
```

```
    clock_t st, end;
    st = clock();
    quickSort(arr, 0, n - 1);
    end = clock();
    double time_taken = (((double)(end - st)) / CLOCKS_PER_SEC);

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

    printf("\nTime taken: %lf micro seconds\n", time_taken * 1000000);
}
```

Output with input size vs time graph:

Quick Sort	
Input Size	Time taken (in micro seconds)
1000	2000
25000	4000
50000	8000
75000	17000
100000	20000
125000	24000
150000	24000
175000	31000
200000	32000
225000	31000
250000	31000





6.Heap Sort

Aim: To sort a given set of N integer elements using Heap Sort technique and compute its time taken

Code:

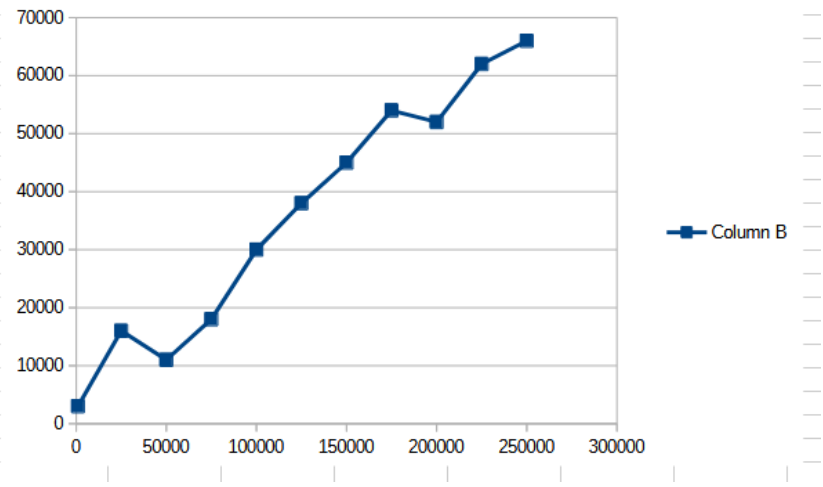
```
#include   <stdio.h>
#include  <stdlib.h>
#include <time.h>


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


void heapify(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]);
        heapify(arr, N, largest);
    }
}

void heapSort(int arr[], int N)
{
    for (int i = N / 2 - 1; i >= 0; i--)
    {
        heapify(arr, N, i);
    }

    for (int i = N - 1; i >= 0; i--)
    {
        swap(&arr[0], &arr[i]);
        heapify(arr, i, 0);
    }
}

int main(void)
{
    int n;
    printf("Enter the size of array: ");
    scanf("%d", &n);
```

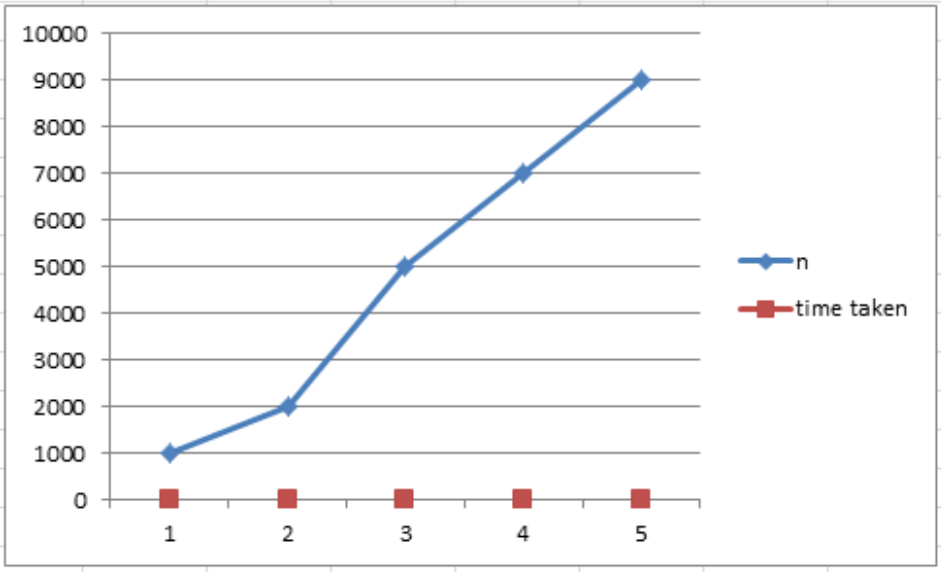
```
    int arr[n];

    // printf("Enter the elements: ");
    srand(time(0));
    for (int i = 0; i < n; i++)
    {
        arr[i] = rand();
    }

    clock_t st, end;
    st = clock();
    heapSort(arr, n);
    end = clock();
    double time_taken = (((double)(end - st)) / CLOCKS_PER_SEC);

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

    printf("\nTime taken: %lf micro seconds\n", time_taken * 1000000);
}
```

Output with input size vs time graph:

Heap Sort	
Input Size	Time taken (in micro seconds)
1000	3000
25000	16000
50000	11000
75000	18000
100000	30000
125000	38000
150000	45000
175000	54000
200000	52000
225000	62000
250000	66000



n	time taken
1000	0.000022
2000	0.000042
5000	0.000092
7000	0.000141
9000	0.000183



7. 0/1 Knapsack Problem

Aim: To optimize(maximize) the items in the knapsack for our requirement using 0/1 Knapsack algorithm

Code:

```
#include <stdio.h>
int main(void)
{
   printf("Enter the number of items: ");
   int n;
   scanf("%d", &n);

   printf("Enter the price of each item: ");
   int price[n];
   int i;
   for (i = 0; i < n; i++)
   {
      scanf("%d", &price[i]);
   }

   printf("Enter the weight of each item: ");
   int weight[n];
   for (i = 0; i < n; i++)
   {
      scanf("%d", &weight[i]);
   }

   printf("Enter the max weight: ");
   int W;
```

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

    printf("\nThe dp table is:\n");
    int dp[n + 1][W + 1];
    for (i = 0; i <= n; i++)
    {
        for (int j = 0; j <= W; j++)
        {
            if (i == 0 || j == 0)
            {
                dp[i][j] = 0;
            }
            else if (weight[i - 1] <= j)
            {
                dp[i][j] = (price[i - 1] + dp[i - 1][j - weight[i - 1]]) > dp[i - 1][j] ? (price[i - 1] + dp[i -
1][j - weight[i - 1]]) : dp[i - 1][j];
            }
            else
            {
                dp[i][j] = dp[i - 1][j];
            }
            printf("%d  ", dp[i][j]);
        }
        printf("\n");
    }

    printf("\nThe maximum value we can get is: %d", dp[n][W]);

    return 0;
```

}

Output:

```
PS D:\codes\ADA Lab> cd "d:\codes\ADA Lab\" ; if ($?) { gcc Knapsack.c -o Knapsack } ; if ($?) { .\Knapsack }
Enter the number of items: 4
Enter the price of each item: 2 3 4 1
Enter the weight of each item: 3 4 5 6
Enter the max weight: 8

The dp table is:
0  0  0  0  0  0  0  0  0
0  0  0  2  2  2  2  2  2
0  0  0  2  3  3  3  5  5
0  0  0  2  3  4  4  5  6
0  0  0  2  3  4  4  5  6

The maximum value we can get is: 6
```

8.Floyd's Algorithm

Aim: To find out the shortest path between all pairs of vertices

Code:

```
#include <stdio.h>

int main(void)
{
   printf("Enter the number of vertices: ");
   int n;
   scanf("%d", &n);

   printf("Enter the adjacency matrix(use 999 as infinity):\n");
   int adj[n][n];
   int i, j, k;
   for (i = 0; i < n; i++)
   {
      for (int j = 0; j < n; j++)
      {
         scanf("%d", &adj[i][j]);
      }
   }

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

```
            if (adj[i][j] > adj[i][k] + adj[k][j])
            {
                adj[i][j] = adj[i][k] + adj[k][j];
            }
        }
    }
}

printf("The shortest path matrix is:\n");
for (i = 0; i < n; i++)
{
    for (j = 0; j < n; j++)
    {
        printf("%d\t", adj[i][j]);
    }
    printf("\n");
}
}
```

Output:

```
PS D:\codes\ADA Lab> cd "d:\codes\ADA Lab\" ; if ($?) { gcc FloydWarshall.c -o FloydWarshall } ; if ($?) { .\FloydWarshall }
Enter the number of vertices: 4
Enter the adjacency matrix(use 999 as infinity):
0 5 999 10
999 0 3 999
999 999 0 1
999 999 999 0
The shortest path matrix is:
0       5       8       9
999     0       3       4
999     999     0       1
999     999     999     0
```

9.Prim's and Kruskal's algorithm

Aim: To find minimal spanning tree of a graph using Prim's and Kruskal's algorithms

Prim's Algorithm Code:

```
#include <stdio.h>
int main(void)
{
   printf("Enter the number of vertices: ");
   int n;
   scanf("%d", &n);

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

   int visited[n];
   for (i = 0; i < n; i++)
   {
      visited[i] = 0;
   }
```

```
printf("Enter the starting vertex: ");
int start;
scanf("%d", &start);
visited[start] = 1;

printf("\nThe minimal spanning tree is:\nEdge : Weight\n");
for (k = 0; k < n - 1; k++)
{
   int min = 999;
   int u = 0;
   int v = 0;
   for (i = 0; i < n; i++)
   {
      if (visited[i])
      {
         for (j = 0; j < n; j++)
         {
            if (!visited[j] && adj[i][j])
            {
               if (min > adj[i][j])
               {
                  min = adj[i][j];
                  u = i;
                  v = j;
               }
            }
         }
      }
```

```
        }
        printf("%d - %d : %d\n", u, v, adj[u][v]);
        visited[v] = 1;
    }
}
```

Output:

```
PS D:\codes\ADA Lab> cd "d:\codes\ADA Lab\" ; if ($?) { gcc Prims.c -o Prims } ; if ($?) { .\Prims }
Enter the number of vertices: 4
Enter the adjacency matrix:
0 2 0 6
2 0 3 8
0 3 0 5
6 8 5 0
Enter the starting vertex: 2

The minimal spanning tree is:
Edge : Weight
2 - 1 : 3
1 - 0 : 2
2 - 3 : 5
```

Kruskal's Algorithm Code:

```
#include <stdio.h>

int find(int v, int *parent)
{
    while (parent[v] != v)
    {
        v = parent[v];
    }
    return v;
}
```

```
void union1(int i, int j, int *parent)
{
    if (i < j)
        parent[j] = i;
    else
        parent[i] = j;
}

int main(void)
{
    printf("Enter the number of vertices: ");
    int n;
    scanf("%d", &n);

    printf("Enter the adjacency matrix(use 999 as infinity):\n");
    int adj[n][n];
    int i;
    for (i = 0; i < n; i++)
    {
        for (int j = 0; j < n; j++)
        {
            scanf("%d", &adj[i][j]);
        }
    }

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

```
}

int count = 0, k = 0, min, sum = 0, j, t[n][n], u, v;

while (count != n - 1)
{
   min = 999;
   for (i = 0; i < n; i++)
   {
      for (j = 0; j < n; j++)
      {
         if (adj[i][j] < min && adj[i][j] != 0)
         {
            min = adj[i][j];
            u = i;
            v = j;
         }
      }
   }

   i = find(u, parent);
   j = find(v, parent);

   if (i != j)
   {
      union1(i, j, parent);
      t[k][0] = u;
      t[k][1] = v;
      k++;
```

```
            count++;
            sum = sum + adj[u][v];
        }
        adj[u][v] = adj[v][u] = 999;
    }

    if (count == n - 1)
    {
        printf("The minimal spanning tree is as:\n");
        for (i = 0; i < n - 1; i++)
        {
            printf("%d -> %d\n", t[i][0], t[i][1]);
        }
        printf("Cost of spanning tree = %d\n", sum);
    }
    else
    {
        printf("\nSpanning tree does not exist!");
    }
}
```

Output:

```
PS D:\codes\ADA Lab> cd "d:\codes\ADA Lab\" ; if ($?) { gcc Kruskal.c -o Kruskal } ; if ($?) { .\Kruskal }
Enter the number of vertices: 4
Enter the adjacency matrix(use 999 as infinity):
0 2 0 6
2 0 3 8
0 3 0 5
6 8 5 0
The minimal spanning tree is as:
0 -> 1
1 -> 2
2 -> 3
Cost of spanning tree = 10
```

10.Dijkstra's Algorithm

Aim: To find shortest paths to other vertices from a given vertex in a weighted connected graph using Dijkstra's algorithm

Code:

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


int main(void)
{
   printf("Enter the number of vertices: ");
   int n;
   scanf("%d", &n);
   int **arr = (int **)malloc(n * sizeof(int *));

   int i, j;
   printf("Enter cost matrix(use 999 for infinity):\n");
   for (i = 0; i < n; i++)
   {
      arr[i] = (int *)malloc(n * sizeof(int));
      for (j = 0; j < n; j++)
      {
         scanf("%d", &arr[i][j]);
      }
   }

   printf("Enter the source vertex: ");
   int src;
```

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

    int dist[n];
    int visited[n];
    for (i = 0; i < n; i++)
    {
        dist[i] = INT_MAX;
        visited[i] = 0;
    }
    dist[src] = 0;

    for (int count = 0; count < n - 1; count++)
    {
        int min = INT_MAX, min_index;
        for (i = 0; i < n; i++)
        {
            if (!visited[i] && dist[i] <= min)
            {
                min = dist[i], min_index = i;
            }
        }

        visited[min_index] = 1;

        for (i = 0; i < n; i++)
        {
            if (!visited[i] && arr[min_index][i] && dist[min_index] != INT_MAX &&
dist[min_index] + arr[min_index][i] < dist[i])
            {
```

```
            dist[i] = dist[min_index] + arr[min_index][i];
        }
      }
    }

    printf("The shortest path from source vertex %d to all other vertices is:\n", src);
    for (i = 0; i < n; i++)
    {
       printf("%d -> %d: %d\n", src, i, dist[i]);
    }

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

Output:

```
PS D:\codes\ADA Lab> cd "d:\codes\ADA Lab\" ; if ($?) { gcc Dijsktras.c -o Dijsktras } ; if ($?) { .\Dijsktras }
Enter the number of vertices: 4
Enter cost matrix(use 999 for infinity):
0  5  3  4
5  0  1  2
3  1  0  4
4  2  4  0
Enter the source vertex: 1
The shortest path from source vertex 1 to all other vertices is:
1 -> 0: 4
1 -> 1: 0
1 -> 2: 1
1 -> 3: 2
```

11.N – Queen's Problem

Aim: To calculate a solution to place N queens in an N x N chess board such that no two queens cancel each other

Code:

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

int n;

bool isSafe(int **arr, int x, int y)
{
   int row, col;

   for (row = 0; row < x; row++)
   {
      if (arr[row][y] == 1)
      {
         return false;
      }
   }

   for (row = x, col = y; row >= 0 && col >= 0; row--, col--)
   {
      if (arr[row][col] == 1)
      {
         return false;
      }
   }
```

```
    for (row = x, col = y; row >= 0 && col < n; row--, col++)
    {
        if (arr[row][col] == 1)
        {
            return false;
        }
    }

    return true;
}

bool nQueen(int **arr, int x)
{
    if (x >= n)
    {
        return true;
    }

    for (int col = 0; col < n; col++)
    {
        if (isSafe(arr, x, col))
        {
            arr[x][col] = 1;

            if (nQueen(arr, x + 1))
            {
                return true;
            }
```

```
            arr[x][col] = 0;
        }
    }

    return false;
}

int main(void)
{
    printf("Enter the size of board: ");
    scanf("%d", &n);
    int **arr = (int **)malloc(n * sizeof(int *));

    int i, j;
    for (i = 0; i < n; i++)
    {
        arr[i] = (int *)malloc(n * sizeof(int));
        for (j = 0; j < n; j++)
        {
            arr[i][j] = 0;
        }
    }

    if (nQueen(arr, 0))
    {
        for (i = 0; i < n; i++)
        {
            for (j = 0; j < n; j++)
            {
```

```
            printf("%d ", arr[i][j]);
        }
        printf("\n");
    }
  }
  else
  {
    printf("\nSolution does not exist!");
  }
}
```

Output:

```
PS D:\codes\ADA Lab> cd "d:\codes\ADA Lab\" ; if ($?) { gcc NQueen.c -o NQueen } ; if ($?) { .\NQueen }
Enter the size of board: 4
0 1 0 0
0 0 0 1
1 0 0 0
0 0 1 0
PS D:\codes\ADA Lab> cd "d:\codes\ADA Lab\" ; if ($?) { gcc NQueen.c -o NQueen } ; if ($?) { .\NQueen }
Enter the size of board: 3

Solution does not exist!
```