VISVESVARAYA TECHNOLOGICAL UNIVERSITY

"JnanaSangama", Belgaum -590014, Karnataka.

LAB REPORT
on

Analysis and Design of Algorithms

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
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Bull Temple Road, Bangalore 560019

(Affiliated To Visvesvaraya Technological University, Belgaum)

Department of Computer Science and Engineering

CERTIFICATE

This is to certify that the Lab work entitled "**Analysis and Design of Algorithms**" carried out by **DIKSHYA ARYAL (1BM21CS058),** who is a 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 June-2023 to September-2023. The Lab report has been approved as it satisfies the academic requirements in respect of a **Analysis and Design of Algorithms (22CS4PCADA)** work prescribed for the said degree.

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Department of CSE	Department of CSE
BMSCE, Bengaluru	BMSCE, Bengaluru

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.

EXPERIMENT 1:

Write program to do the following:

a. Print all the nodes reachable from a given starting node in a digraph using BFS method.

b. Check whether a given graph is connected or not using DFS method.

a.BFS

```
#include<stdio.h>

int a[20][20],q[20],visited[20],n,
f=-1,r=-1;

void bfs(int v)
{
      int i;
      for (i=0;i<n;i++)
      {
            if(a[v][i] != 0 && visited[i] == 0)
            {
                  r=r+1;
                  q[r]=i;
                  visited[i]=1;
                  printf("%d  ",i);
            }
      }
      f=f+1;
      if(f<=r)
        bfs(q[f]);
}
void main()
{
```

```
    int v,i,j;
    printf("\nEnter the number of vertices:");
    scanf("%d",&n);
    for (i=0;i<n;i++)
    {
        visited[i]=0;
    }
    printf("\nEnter graph data in matrix form:\n");
    for (i=0;i<n;i++)
      for (j=0;j<n;j++)
       scanf("%d",&a[i][j]);
    printf("\nEnter the starting vertex:");
    scanf("%d",&v);
    f=r=0;
    q[r]=v;
    printf("\nBFS traversal is:\n");
    visited[v]=1;
    printf("%d   ",v);

    bfs(v);
    if(r != n-1)
        printf("\nBFS is not possible");
}
```

OUTPUT:

```
Enter the number of vertices:4
Enter graph data in matrix form:
1 0 1 0
0 0 1 1
1 0 1 1
0 0 0 1
Enter the starting vertex:1
BFS traversal is:
1   2  3  0
```

```
Enter the number of vertices:4
Enter graph data in matrix form:
1 0 1 0
0 0 1 1
1 0 1 1
0 0 0 1
Enter the starting vertex:1
BFS traversal is:
1   2  3  0
```

b. DFS

```
#include<stdio.h>

int a[20][20],reach[20],n;
void dfs(int v){
    int i;
    reach[v]=1;
    for(i=1;i<=n;i++)
       if(a[v][i]&&!reach[i]){
          printf("\n%d->%d",v,i);
          dfs(i);
          }
 }
 int main(){
   int i,j,count=0;
   printf("\nEnter no of vertices : ");
   scanf("%d",&n);
   for(i=1;i<=n;i++)
      for(j=1;j<=n;j++){
      reach[i]=0;
      a[i][j]=0;
      }

   printf("\nEnter adjacency matrix : \n");
   for(i=1;i<=n;i++)
     for(j=1;j<=n;j++)
       scanf("%d",&a[i][j]);

   dfs(1);
   for(i=1;i<=n;i++)
     if(reach[i])
       count++;
   if(count==n)
     printf("\nGraph is connected.");
   else
```

```
    printf("\nGraph is disconnected.");
  return(0);
```

OUTPUT:

```
Enter no of vertices : 4
Enter adjacency matrix :
1 0 1 0
1 1 1 1
0 0 0 0
1 0 0 1
1->3
Graph is disconnected.
```

```
Enter no of vertices : 4
Enter adjacency matrix :
0 1 1 1
0 0 0 1
0 0 0 0
0 0 1 0
1->2
2->4
4->3
Graph is connected.
```

EXPERIMENT 2:

Write a program to obtain the Topological ordering of vertices in a given digraph.

```
#include<stdio.h>
void main()
{
	int a[20][20],rem[20],ind,n,i,j,flag=0,t=0;
	printf("\nEnter the value of n ");
	scanf("%d",&n);
	printf("\nEnter the adjacency matrix ");
	for(i=0;i<n;i++)
	{
	rem[i]=0;
	for(j=0;j<n;j++)
	{
	scanf("%d",&a[i][j]);
	}
	}
	while(flag==0)
	{
	flag=1;
	for(i=0;i<n;i++)
	{
	if(rem[i]==0)
	{
		ind=0;
		for(j=0;j<n;j++)
		{
		if(!(rem[j]==1||a[j][i]==0))
		{
		ind=1;
		break;
		}
		}
		if(ind==0)
```

```
            {
            printf("%s",t==0?"\nTopological ordering is ":"");
            rem[i]=1;
            printf("%d ",i+1);
            flag=0;
            t++;
            break;
            }
        }
        }
        }
        if(t!=n)
        {
        printf("\nTopological ordering is not possible(it can only be partially ordered)!!");
        }
}
```

OUTPUT:

```
Enter the value of n 5
Enter the adjacency matrix
0 1 1 1 0
0 0 0 0 0
0 0 0 0 1
0 0 0 0 0
0 0 0 0 0
Topological ordering is 1 2 3 4 5
```

EXPERIMENT 3:

Implement Johnson Trotter algorithm to generate permutations.

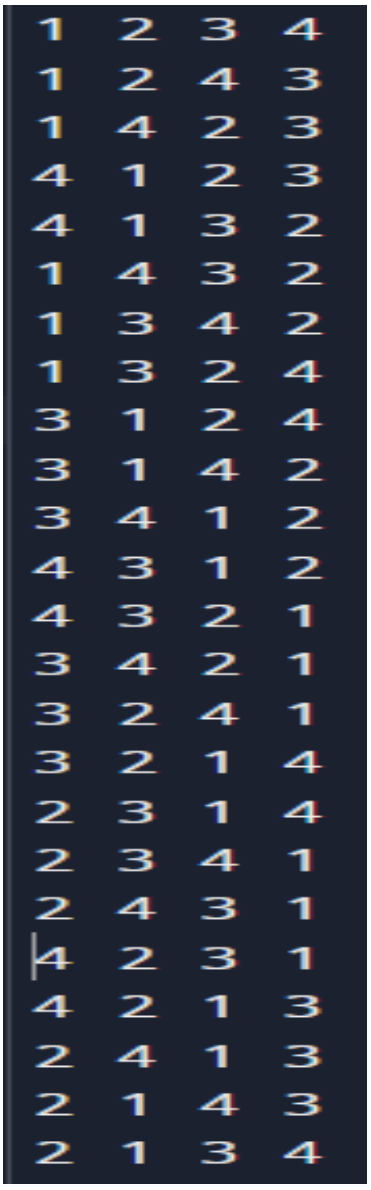
```
#include <stdio.h>
#include <stdbool.h>

bool LEFT_TO_RIGHT = true;
bool RIGHT_TO_LEFT = false;

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


int searchArr(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 mobile_prev = 0, mobile = 0;
        for (int i = 0; i < n; i++) {
        if (dir[a[i] - 1] == RIGHT_TO_LEFT && i != 0) {
        if (a[i] > a[i - 1] && a[i] > mobile_prev) {
                mobile = a[i];
                mobile_prev = mobile;
        }
        }
```

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

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

void printOnePerm(int a[], bool dir[], int n)
{
        int mobile = getMobile(a, dir, n);
        int pos = searchArr(a, n, mobile);


        if (dir[a[pos - 1] - 1] == RIGHT_TO_LEFT)
        swap(&a[pos - 1], &a[pos - 2]);

        else if (dir[a[pos - 1] - 1] == LEFT_TO_RIGHT)
        swap(&a[pos], &a[pos - 1]);

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

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


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


void printPermutation(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] = RIGHT_TO_LEFT;

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

```
}

int main()
{
        int n = 4;
        printPermutation(n);
        return 0;
}
```

OUTPUT:



EXPERIMENT 4:

Sort a given set of N integer elements using Merge Sort technique and compute its time taken. Run the program for different values of N and record the time taken to sort.

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

void merge(int arr[], int l, int m, int r)
{
	int i, j, k;
	int n1 = m - l + 1;
	int n2 = r - m;

	int L[n1], R[n2];

	for (i = 0; i < n1; i++)
		L[i] = arr[l + i];
	for (j = 0; j < n2; j++)
		R[j] = arr[m + 1 + j];

	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++;
		}
```

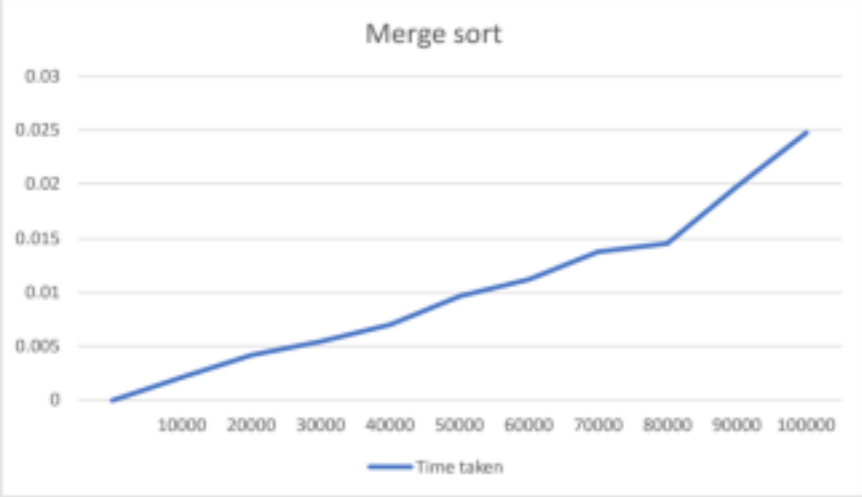
```
            k++;
        }


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


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


void printArray(int A[], int size)
{
        int i;
        for (i = 0; i < size; i++)
```

```
            printf("%d ", A[i]);
        printf("\n");
}


int main()
{
        int arr[200], num, i;
        clock_t start, end;




        printf("Enter no of elements in the array\t");
        scanf("%d", &num);

        printf("Enter the array\n");
        for (i=0;i<num;i++)
        {
            arr[i] = rand();

        }
        printf("Given array is \t");
        printArray(arr, num);

        start = clock();
        mergeSort(arr, 0, num - 1);
        end = clock();

        printf("\nSorted array is \n");
        printArray(arr, num);

        printf("Amount of time taken is: %f", ((double)(end-start))/CLOCKS_
PER_SEC);
        return 0;
```

OUTPUT:

```
Enter no of elements in the array   5
Enter the array
Given array is  1804289383 846930886 1681692777 1714636915 1957747793

Sorted array is
846930886 1681692777 1714636915 1804289383 1957747793
Amount of time taken is: 0.000002
```

GRAPH:



EXPERIMENT 5:

Sort a given set of N integer elements using Quick Sort technique and compute its time taken.

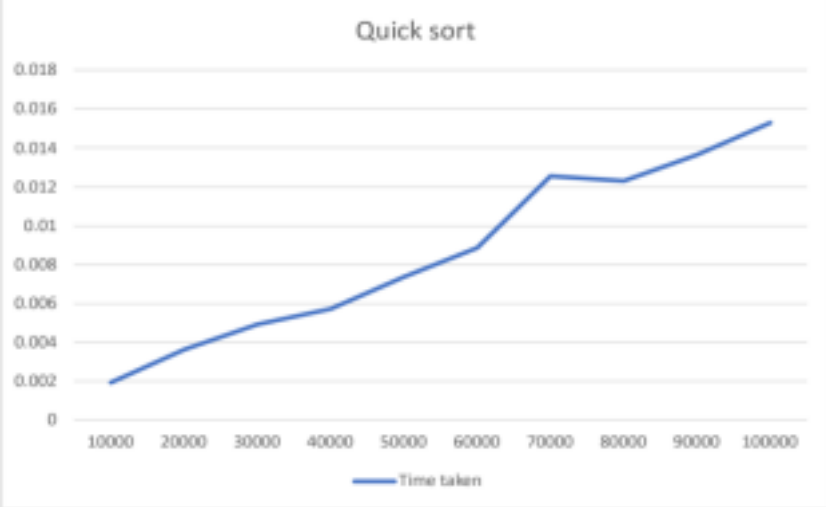
```
#include<stdio.h>
#include<time.h>
#include<stdlib.h>
int partition(int a[],int low,int high)
{
int key,i,j,temp;
key=a[low];
i=low+1;
j=high;
while(1)
{
while(i<high && key>=a[i])
i++;
while(key<a[j])
j--;
if(i<j)
{
temp=a[i];
a[i]=a[j];
a[j]=temp;
}
else
{
temp=a[low];
a[low]=a[j];
a[j]=temp;
return j;
}
}
}
```

```
void quicksort(int a[],int low,int high)
{
int j;
if(low<high)
{
j=partition(a,low,high);
quicksort(a,low,j-1);
quicksort(a,j+1,high);
}
}
void main()
{
int a[10000],n,t,i;
clock_t end,start;
printf("Enter the number of array elements:\n");
scanf("%d",&n);
printf("Enter the array elements:\n");
for(i=0;i<n;i++)
{
a[i]=rand()%1000;
printf("%d\n",a[i]);
}
start=clock();
for(int j=0;j<5000000;j++)
t=900/900;
quicksort(a,0,n-1);
end=clock();
printf("Sorted array:\n");
for(i=0;i<n;i++)
{
printf("%d\n",a[i]);
}
printf("Time taken to search an given element in an array of is
%f\n",(((double)(end-start))/CLOCKS_PER_SEC));
}
```

OUTPUT:

```
Enter the number of array elements:
5
The array elements are:
383 886 777 915 793

Sorted array:
383  777  793  886  915

Time taken to search an given element in an array of is 0.003845
```

GRAPH:



EXPERIMENT 6:

Sort a given set of N integer elements using Heap Sort technique and compute its time taken.

```
#include <stdio.h>
#include <time.h>
clock_t start, end;

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);
}
}
```

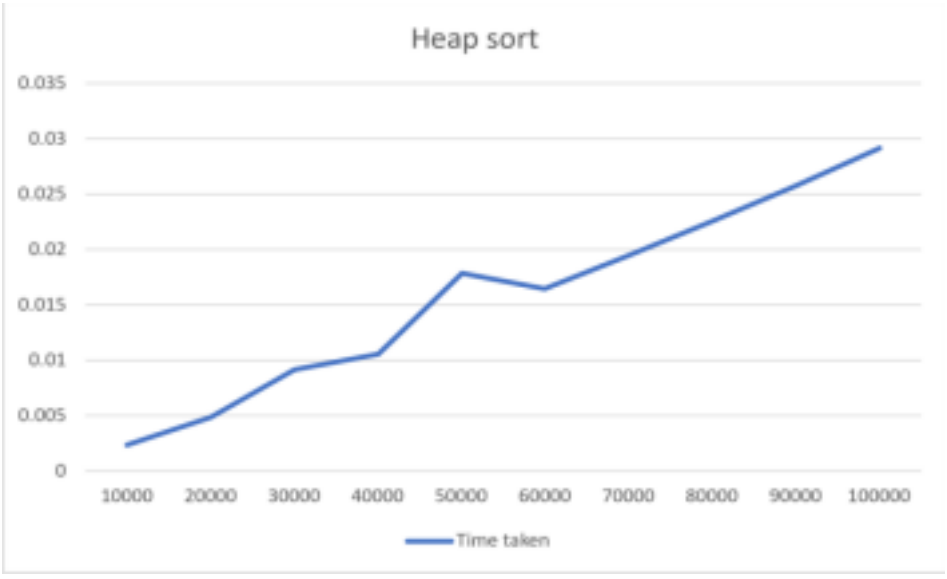
```
void heapSort(int arr[], int N)
{

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);
}
}

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

int main()
{
int arr[1000];
int N;
printf("Enter number of elements:");
scanf("%d",&N);

printf("\nEnter elements:");
for (int i=0; i<N; i++)
{arr[i]=rand();}
start=clock();
heapSort(arr, N);
end=clock();
printf("Sorted array is\n");
```

```
printArray(arr, N);
printf("\n Time taken to sort: %f seconds",(double)(end-start)/CLOCKS_PER_SEC);
}
```

OUTPUT:

```
Enter number of elements:5
Elements are:
1804289383  846930886   1681692777  1714636915  1957747793
Sorted array is
846930886 1681692777 1714636915 1804289383 1957747793

Time taken to sort: 0.000002 seconds
```

GRAPH:



EXPERIMENT 7:

Implement 0/1 Knapsack problem using dynamic programming.

```
#include <stdio.h>

int max(int a, int b) {
	return (a > b) ? a : b;
}

int knapSack(int W, int wt[], int val[], int n, int selected[]) {
	int i, w;
	int K[n + 1][W + 1];

	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];
	}
	}

	int res = K[n][W];
	w = W;
	for (i = n; i > 0 && res > 0; i--) {
	if (res == K[i - 1][w])
	continue;
	else {
	selected[i - 1] = 1;
	res = res - val[i - 1];
	w = w - wt[i - 1];
	}
	}
```

```
    return K[n][W];
}

int main() {
    int n, W, i;
    printf("Enter the number of items: ");
    scanf("%d", &n);
    int val[n], wt[n], selected[n];
    printf("Enter the values of the items: ");
    for (i = 0; i < n; i++)
    scanf("%d", &val[i]);
    printf("Enter the weights of the items: ");
    for (i = 0; i < n; i++)
    scanf("%d", &wt[i]);
    printf("Enter the capacity of the knapsack: ");
    scanf("%d", &W);
    int max_profit = knapSack(W, wt, val, n, selected);
    printf("The maximum profit is %d\n", max_profit);
    printf("The objects selected for the optimal solution are: ");
    for (i = 0; i < n; i++) {
    if (selected[i])
    printf("%d ", i + 1);
    }
    return 0;
}
```

OUTPUT:

```
Enter the number of items: 4
Enter the values of the items: 23 65 8 12
Enter the weights of the items: 2 54 7 9
Enter the capacity of the knapsack: 65
The maximum profit is 100
```

EXPERIMENT 8:

Implement All Pair Shortest paths problem using Floyd's algorithm.

```
#include<stdio.h>
#include<conio.h>
int a[10][10],n;
void floyd();
int min(int,int);
void main()
{
int i,j;
printf("Enter the number of vertices\n");
scanf("%d",&n);
printf("Enter the adjacency matrix:\n");
for(i=1;i<=n;i++)
{
for(j=1;j<=n;j++)
{
scanf("%d",&a[i][j]);
}
}
floyd();
}
void floyd()
{
int i,j,k;
for(k=1;k<=n;k++)
{
for(i=1;i<=n;i++)
{
for(j=1;j<=n;j++)
{
a[i][j]=min(a[i][j],a[i][k]+a[k][j]);
}
```

```
}
}
printf("All pair of shortest path matrix is:\n");
for(i=1;i<=n;i++)
{
for(j=1;j<=n;j++)
{
printf("%d\t",a[i][j]);
}
printf("\n\n");
}
}
int min(int x,int y)
{
if(x<y)
return x;
else
return y;
}
```

OUTPUT:

```
Enter the number of vertices
4
Enter the adjacency matrix:
9999 9999 3 9999
2 9999 9999 9999
9999 7 9999 1
6 9999 9999 9999
9999 9999 3 9999
```

```
All pair of shortest path matrix is:
10  10  3   4

2   12  5   6

7   7   10  1

6   16  9   10
```

EXPERIMENT 9:

Find Minimum Cost Spanning Tree of a given undirected graph using Prim's and Kruskal's algorithm.

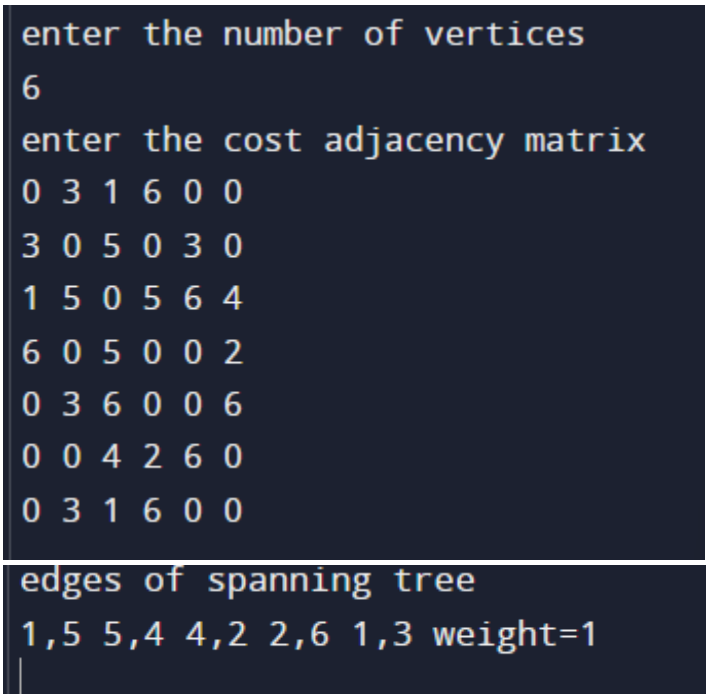
a. Prim's Algorithm

```
#include<stdio.h>

int cost[10][10],vt[10],et[10][10],vis[10],j,n;
int sum=0;
int x=1;
int e=0;
void prims();

void main()
{
  int i;
  printf("enter the number of vertices\n");
  scanf("%d",&n);
  printf("enter the cost adjacency matrix\n");
  for(i=1;i<=n;i++)
  {
       for(j=1;j<=n;j++)
       {
    scanf("%d",&cost[i][j]);
       }
       vis[i]=0;
       }
       prims();
       printf("edges of spanning tree\n");
       for(i=1;i<=e;i++)
       {
   printf("%d,%d\t",et[i][0],et[i][1]);
       }
       printf("weight=%d\n",sum);
```

```
}

void prims()
{
  int s,min,m,k,u,v;
  vt[x]=1;
  vis[x]=1;
  for(s=1;s<n;s++)
  {
        j=x;
        min=999;
        while(j>0)
        {
        k=vt[j];
        for(m=2;m<=n;m++)
        {
        if(vis[m]==0)
        {
         if(cost[k][m]<min)
         {
                min=cost[k][m];
                u=k;
                v=m;
         }
        }
    }
    j--;
        }
        vt[++x]=v;
        et[s][0]=u;
        et[s][1]=v;
        e++;
        vis[v]=1;
        sum=sum+min;
 }
```

}

OUTPUT:


enter the number of vertices
6
enter the cost adjacency matrix
0 3 1 6 0 0
3 0 5 0 3 0
1 5 0 5 6 4
6 0 5 0 0 2
0 3 6 0 0 6
0 0 4 2 6 0
0 3 1 6 0 0
edges of spanning tree
1,5 5,4 4,2 2,6 1,3 weight=1

b. Kruskal's Algorithm

```
#include<stdio.h>

int find(int v,int parent[10])
{
  while(parent[v]!=v)
  {
        v=parent[v];
  }
  return v;
}

void union1(int i,int j,int parent[10])
{
  if(i<j)
        parent[j]=i;
  else
        parent[i]=j;
}

void kruskal(int n,int a[10][10])
{
  int count,k,min,sum,i,j,t[10][10],u,v,parent[10];
  count=0;
  k=0;
  sum=0;
  for(i=0;i<n;i++)
        parent[i]=i;
  while(count!=n-1)
  {
        min=999;
        for(i=0;i<n;i++)
        {
    for(j=0;j<n;j++)
```

```
  {

      if(a[i][j]<min && a[i][j]!=0)
      {
       min=a[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+a[u][v];
      }
      a[u][v]=a[v][u]=999;
      }
      if(count==n-1)
      {
      printf("spanning tree\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("spanning tree does not exist\n");
}
```

```
void main()
{
  int n,i,j,a[10][10];
  printf("enter the number of nodes\n");
  scanf("%d",&n);
  printf("enter the adjacency matrix\n");
  for(i=0;i<n;i++)
        for(j=0;j<n;j++)
   scanf("%d",&a[i][j]);
  kruskal(n,a);
}
```

OUTPUT:

```
enter the number of nodes
4
enter the adjacency matrix
2 5 0 0
999 0 3 8
1 2 5 4
6 8 3 0
spanning tree
2 0
2 1
3 2
cost of spanning tree=6
```

EXPERIMENT 10:

From a given vertex in a weighted connected graph, find shortest paths to other vertices using Dijkstra's algorithm.

```
#include <stdio.h>
#define INFINITY 9999
#define MAX 10

void Dijkstra(int Graph[MAX][MAX], int n, int start);

void Dijkstra(int Graph[MAX][MAX], int n, int start) {
  int cost[MAX][MAX], distance[MAX], pred[MAX];
  int visited[MAX], count, mindistance, nextnode, i, j;

  // Creating cost matrix
  for (i = 0; i < n; i++)
    for (j = 0; j < n; j++)
      if (Graph[i][j] == 0)
        cost[i][j] = INFINITY;
      else
        cost[i][j] = Graph[i][j];

  for (i = 0; i < n; i++) {
    distance[i] = cost[start][i];
    pred[i] = start;
    visited[i] = 0;
  }

  distance[start] = 0;
  visited[start] = 1;
  count = 1;

  while (count < n - 1) {
    mindistance = INFINITY;
```

```
    for (i = 0; i < n; i++)
      if (distance[i] < mindistance && !visited[i]) {
        mindistance = distance[i];
        nextnode = i;
      }

    visited[nextnode] = 1;
    for (i = 0; i < n; i++)
      if (!visited[i])
        if (mindistance + cost[nextnode][i] < distance[i]) {
          distance[i] = mindistance + cost[nextnode][i];
          pred[i] = nextnode;
        }
    count++;
  }

  // Printing the distance
  for (i = 0; i < n; i++)
    if (i != start) {
      printf("\nDistance from source to %d: %d", i, distance[i]);
    }
}
int main() {
  int Graph[MAX][MAX], i, j, n, u;
printf("Enter number of nodes:");
scanf("%d",&n);
printf("Enter matrix:");
for (i=0; i<n;i++)
{
for (j=0; j<n;j++)
{scanf("%d",&Graph[i][j]);
}
}
  printf("Enter initial vertex:");
  scanf("%d",&u);
```

```
4

Dijkstra(Graph, n, u);

return 0;
```

OUTPUT:

```
Enter number of nodes:5
Enter matrix:9999 3 9999 7 9999
3 9999 4 2 9999
9999 4 9999 5 6
7 2 5 9999 4
9999 9999 6 4 9999
```

```
Enter initial vertex:3
Distance from source to 0: 5
Distance from source to 1: 2
Distance from source to 2: 5
Distance from source to 4: 4
```

EXPERIMENT 11:

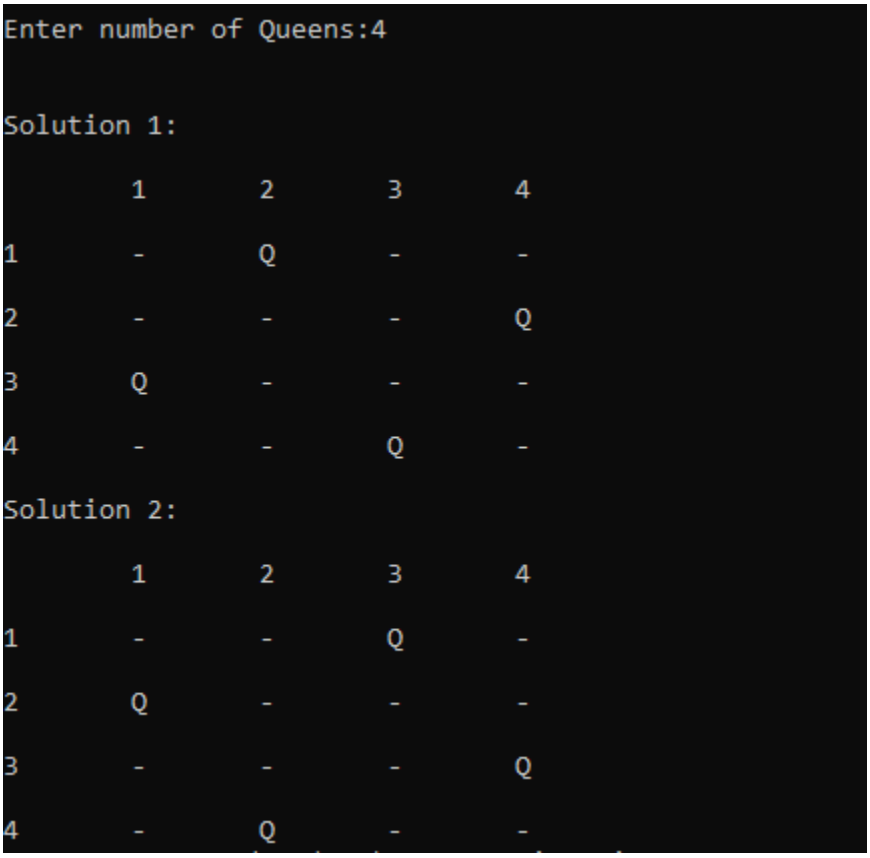
Implement “N-Queens Problem” using Backtracking.

```
#include<stdio.h>
#include<math.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;
}

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)
  {
   if(board[i]==j)
    printf("\tQ");
```

```
   else
    printf("\t-");
  }
}
}

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)
{
  if(board[i]==column)
   return 0;
  else
   if(abs(board[i]-column)==abs(
i-row))
    return 0;
}

return 1; }

void queen(int row,int n)
{
int column;
for(column=1;column<=n;++column)
{
  if(place(row,column))
  {
   board[row]=column;
   if(row==n)
    print(n);
   else
    queen(row+1,n);
  }
```

```
}
}
```

OUTPUT:


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 - -