

VISVESVARAYA TECHNOLOGICAL UNIVERSITY

“JnanaSangama”, Belgaum -590014, Karnataka.



LAB REPORT on

Analysis and Design of Algorithms

Submitted by

Chandrasekhar Patil (1BM21CS043)

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,
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 **Chandrasekhar Patil (1BM21CS043)**, 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 an **Analysis and Design of Algorithms (22CS4PCADA)** work prescribed for the said degree.

Name of the Lab-In charge: **Dr. Rajeshwari B S**

Assistant Professor

Department of CSE

BMSCE, Bengaluru

Dr. Jyothi S Nayak

Professor and Head

Department of CSE

BMSCE, Bengaluru

Index Sheet

Lab Program No.	Program Details	Page No.
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.	1
2	Write program to obtain the Topological ordering of vertices in a given digraph.	5
3	Implement Johnson Trotter algorithm to generate permutations.	7
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.	12
5	Sort a given set of N integer elements using Quick Sort technique and compute its time taken.	16
6	Sort a given set of N integer elements using Heap Sort technique and compute its time taken.	19
7	Implement 0/1 Knapsack problem using dynamic programming.	24
8	Implement All Pair Shortest paths problem using Floyd's algorithm.	27
9	Find Minimum Cost Spanning Tree of a given undirected graph using Prim's and Kruskal's algorithm.	29
10	From a given vertex in a weighted connected graph, find shortest paths to other vertices using Dijkstra's algorithm.	36
11	Implement "N-Queens Problem" using Backtracking.	40

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.

Write program to do the following:

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

```
#include<stdio.h>
int n,i,j,visited[10],queue[10],front=0,rear=-1;
int adj[10][10];
void bfs(int v)
{
    for(i=1;i<=n;i++)
        if(adj[v][i] && !visited[i])
            queue[++rear]=i;
    if(front<=rear)
    {
        visited[queue[front]]=1;
        bfs(queue[front++]);
    }
}
int main()
{
    int v;
    printf("Enter the number of vertices\n");
    scanf("%d",&n);
    for(i=1;i<=n;i++)
    {
        queue[i]=0;
        visited[i]=0;
    }
    printf("Enter graph data in the form of adjacency matrix\n");
    for(i=1;i<=n;i++)
    {
        for(j=1;j<=n;j++)
        {
            scanf("%d",&adj[i][j]);
        }
    }
    printf("\nEnter the starting vertex\n");
    scanf("%d",&v);
```

```

    bfs(v);
    printf("The nodes which are reachable are:\n");
    for(i=1;i<=n;i++)
    {
        if(visited[i])
        {
            printf("%d\t",i);
        }
        else
        {
            printf("node not visited");
        }
    }

    return 1;
}

```

Output:

```

Enter the number of vertices
5
Enter graph data in the form of adjacency matrix
0 1 0 1 0
1 0 1 1 0
0 1 0 0 1
1 1 0 0 1
0 0 1 1 0

Enter the starting vertex
1
The nodes which are reachable are:
1      2      3      4      5

```

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

```
#include<stdio.h>
int a[20][20],visited[20],n;
void dfs(int v)
{
    int i;
    visited[v]=1;
    for(i=0;i<n;i++)
    {
        if(a[v][i] && !visited[i])
        {
            printf("\n%d->%d",v,i);
            dfs(i);
        }
    }
}
```

```

int main()
{
    int i,j,count=0;
    printf("Enter number of vertices ");
    scanf("%d",&n);
    for(i=0;i<n;i++)
    {
        for(j=0;j<n;j++)
        {
            visited[i]=0;
            a[i][j]=0;
        }
    }
    for(i=0;i<n;i++)
    {
        for(j=0;j<n;j++)
        {
            scanf("%d",&a[i][j]);
        }
    }
    dfs(0);
    for(i=0;i<n;i++)
    {
        if(visited[i])
            count++;
    }
    if(count==n)
    {
        printf("\nGraph is connected\n");
    }
    else

```



```
    {  
        printf("Graph is disconnected");  
    }  
    return 1;  
}
```

Output:

```
Enter number of vertices 5  
0 1 0 1 0  
1 0 1 1 0  
0 1 0 0 1  
1 1 0 0 1  
0 0 1 1 0  
  
0->1  
1->2  
2->4  
4->3  
Graph is connected
```

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

```
#include<stdio.h>
void dfs(int);
int a[10][10],vis[10],exp[10],n,j,m;

void main()
{

    int i,x,y;
    printf("enter the number of vertices\n");
    scanf("%d",&n);
    for(i=1;i<=n;i++)
    {
        for(j=1;j<=n;j++)
        {
            a[i][j]=0;
        }
        vis[j]=0;
    }
    printf("Enter the number of edges\n");
    scanf("%d",&m);
    for(i=1;i<=m;i++)
    {
        printf("Enter an edge\n");
        scanf("%d%d",&x,&y);
        a[x][y]=1;
    }
    j=0;
    for(i=1;i<=n;i++)
    {
        if(vis[i]==0)
            dfs(i);
    }
    printf("The topological sort\n");
    for(i=n-1;i>=0;i--)
    {
```

```

        printf("%d\t",exp[i]);
    }
}
void dfs(int v)
{
    int i;
    vis[v]=1;
    for(i=1;i<=n;i++)
    {
        if(a[v][i]==1 && vis[i]==0)
        {
            dfs(i);
        }
    }
    exp[j++]=v;
}

```

Output:

```

enter the number of vertices
5
Enter the number of edges
6
Enter an edge
1 2
Enter an edge
2 4
Enter an edge
4 5
Enter an edge
5 3
Enter an edge
3 1
Enter an edge
1 2
The topological sort
1      2      4      5      3

```

Implement Johnson Trotter algorithm to generate permutations.

```
#include<stdio.h>

#define RIGHT_TO_LEFT 0
#define LEFT_TO_RIGHT 1

int searchArr(int a[],int n,int mobile)
{
    int i;
    for(i=0;i<n;i++)
    {

        if(a[i]==mobile)
            return i+1;
    }
    return -1;
}

int getMobile(int a[],int dir[],int n)
{

    int i,mobile_prev=0,mobile=0;
    for(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;
    }
}

}

return mobile;
}

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

```

```

temp=*a;

*a=*b;

*b=temp;
}

void printOnePerm(int a[],int dir[],int n)
{
    int i;

    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(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(i=0;i<n;i++)
    {

        printf("%d",a[i]);

    }

    printf(" ");
}

int fact(int n)
{

    int i, res=1;

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

        res*=i;

    return res;
}

void printPermutations(int n)
{

    int i, a[n];

    int dir[n];

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

    {

        a[i]=i+1;

```

```

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

int main()
{
    int n;

    printf("Enter the number of digits\n");

    scanf("%d",&n);

    printf("Permutations of the sequeence :");

    printPermutations(n);return 0;
}

```

Output:

```

Enter the number of digits
4
Permutations of the sequeence :1234
1243 1423 4123 4132 1432 1342 1324 3124 3142 3412 4312 4321 3421 3241 3214 2314 2341 2431 4231 4213 2413 2143 2134

```


**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<time.h>
#include<stdlib.h>
void merge(int arr[],int l,int r,int m)
{
    int i,j,k;

    int n1=m-l+1;
    int n2=r-m;
    int left[n1], right[n2];
    for(i=0;i<n1;i++)
    {
        left[i]=arr[l+i];
    }
    for(j=0;j<n2;j++)
    {
        right[j]=arr[m+1+j];
    }
    i=0;
    j=0;
    k=l;
    while(i<n1 && j<n2)
    {
        if(left[i]<=right[j])
        {
            arr[k]=left[i];
            i++;
        }
        else
        {
            arr[k]=right[j];
            j++;
        }
        k++;
    }
}
```

```

while(i<n1)
{
    arr[k]=left[i];
    i++;
    k++;
}
while(j<n2)
{
    arr[k]=right[j];
    j++;
    k++;
}
}
void mergesort(int arr[], int l, int r)
{
    int mid;
    if(l<r)
    {
        mid=l+(r-l)/2;
        mergesort(arr,l,mid);
        mergesort(arr,mid+1,r);
        merge(arr,l,r,mid);
    }
}
void print(int arr[],int n)
{
    int i;
    for(i=0;i<n;i++)
    {
        printf("%d\t",arr[i]);
    }
}

void main()
{
    int arr[200000],n,i;
    clock_t st,et;
    float ts;

```

```

printf("Enter the size of the array\n");
scanf("%d",&n);
for(i=0;i<n;i++)
{
    arr[i]=rand();
}
if(n<=20)
{
    printf("before sorting \n");
    print(arr,n);
}

st=clock();

mergesort(arr,0,n-1);

et=clock();
ts=(float)(et-st)/CLOCKS_PER_SEC;
if(n<=20)
{
    printf("\nafter sorting using mergesort\n");
    print(arr,n);
}

//print(arr,n);
printf("\nTime taken \t %f ",ts);

}

```

Output:

```

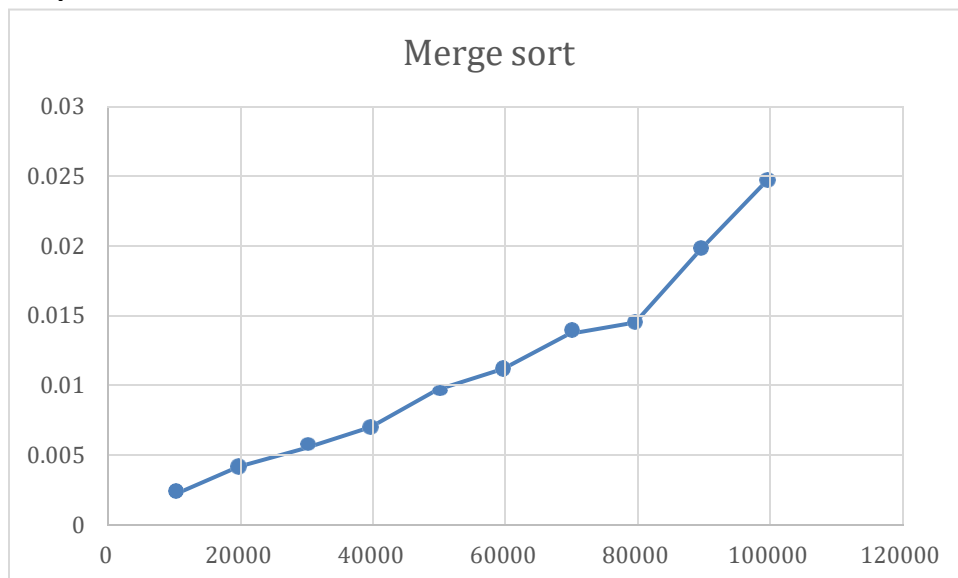
Enter the size of the array
6
before sorting
41    18467    6334    26500    19169    15724
after sorting using mergesort
41    6334    15724    18467    19169    26500    41    6334    15724    18467    19169    26500

```

Table of values:

Input size(n)	Time taken
10000	0.002114
20000	0.00418
30000	0.005486
40000	0.007019
50000	0.00969
60000	0.011191
70000	0.013704
80000	0.014539
90000	0.019828
100000	0.024749

Graph:



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>
void swap(int *a,int *b)
{
    int temp;
    temp=*a;
    *a=*b;
    *b=temp;
}
int partition(int arr[],int l,int r)
{
    //ascending order
    int pivot=arr[r];
    int i=l-1,j;
    for(j=l;j<=r-1;j++)
    {
        if(arr[j]<pivot)
        {
            i++;
            swap(&arr[i],&arr[j]);
        }
    }
    swap(&arr[i+1],&arr[r]);
    return (i+1);
}
void quicksort(int arr[],int l,int r)
{
    int split;
    if(l<r)
    {
        split=partition(arr,l,r);
        quicksort(arr,l,split-1);
        quicksort(arr,split+1,r);
    }
}
```

```

}
void print(int arr[],int n)
{
    int i;
    for(i=0;i<n;i++)
    {
        printf("%d\t",arr[i]);
    }
}
void main()
{
    int arr[200000],n,i;
    clock_t st,et;
    float ts;
    printf("Enter the size of the array\n");
    scanf("%d",&n);
    for(i=0;i<n;i++)
    {
        arr[i]=rand();
    }
    if(n<=20)
    {
        printf("before sorting \n");
        print(arr,n);
    }
    st=clock();
    //print(arr,n);
    quicksort(arr,0,n-1);
    et=clock();
    ts=(float)(et-st)/CLOCKS_PER_SEC;
    if(n<=20)
    {
        printf("\nafter sorting using quicksort\n");
        print(arr,n);
    }

    printf("\nTime taken \t %f ",ts);
}

```

}

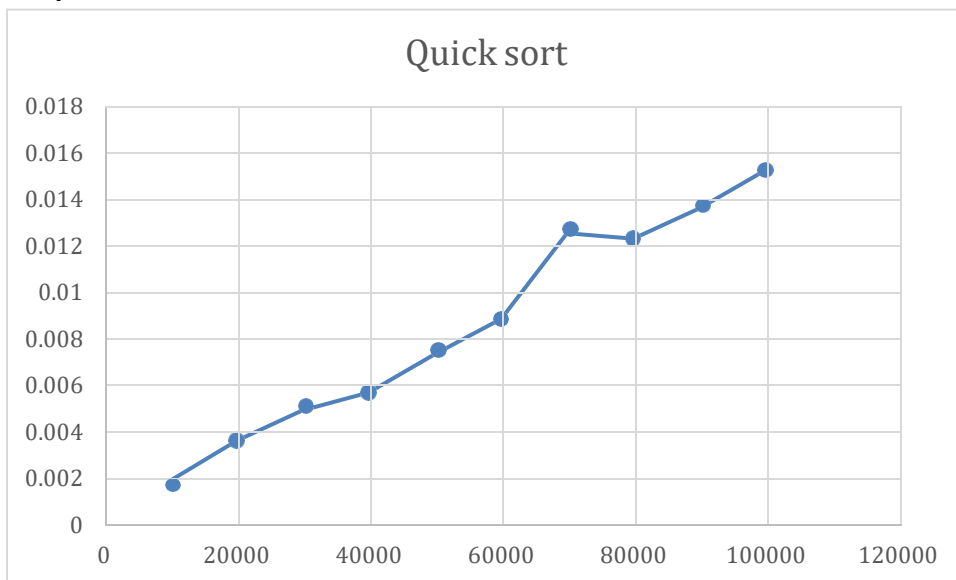
Output:

```
Enter the size of the array
5
before sorting
41      18467  6334    26500   19169
after sorting using quicksort
41      6334   18467   19169   26500
```

Table of values:

Input size(n)	Time taken
10000	0.001908
20000	0.003618
30000	0.004931
40000	0.005698
50000	0.00735
60000	0.008865
70000	0.012559
80000	0.012323
90000	0.013631
100000	0.015273

Graph:



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

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

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

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

```
void swap(int *a, int *b) {
```

```
    int temp = *a;
```

```
    *a = *b;
```

```
    *b = temp;
```

```
}
```

```
void heapify(int a[], int n, int i) {
```

```
    int largest = i, l = 2 * i + 1, r = 2 * i + 2;
```

```
    while (l < n && a[l] > a[largest]) {
```

```
        largest = l;
```

```
    }
```

```
    while (r < n && a[r] > a[largest]) {
```

```
        largest = r;
```

```
    }
```

```
    if (largest != i) {
```

```
        swap(&a[i], &a[largest]);
```

```
        heapify(a, n, largest);
```

```
    }
```

```
}
```



```

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

```

```

void heapsort(int a[], int n) {
    int i;
    // Create max heap
    for (i = n / 2 - 1; i >= 0; i--) {
        heapify(a, n, i);
    }

```

```

    // Sort using deletion
    for (i = n - 1; i >= 0; i--) {
        swap(&a[0], &a[i]);
        heapify(a, i, 0);
    }
}

```

```

int main() {

```

```

int n, i;

clock_t st, et;

float ts;

printf("Enter the number of elements\n");

scanf("%d", &n);


// Dynamically allocate the array

int *a = (int *)malloc(n * sizeof(int));

if (a == NULL) {

    printf("Memory allocation failed.\n");

    return 1;

}


// Generate random values and place them in the array

for (i = 0; i < n; i++) {

    a[i] = rand();

}


st = clock();

heapsort(a, n);

et = clock();

ts = (float)(et - st) / CLOCKS_PER_SEC;


if (n <= 20) {

```

```

    printf("\nAfter sorting elements are\n");

    print(a, n);

}

// Free dynamically allocated memory

free(a);

printf("\nTime taken: %f seconds\n", ts);

return 0;

}

```

Output:

```

Enter the number of elements
5

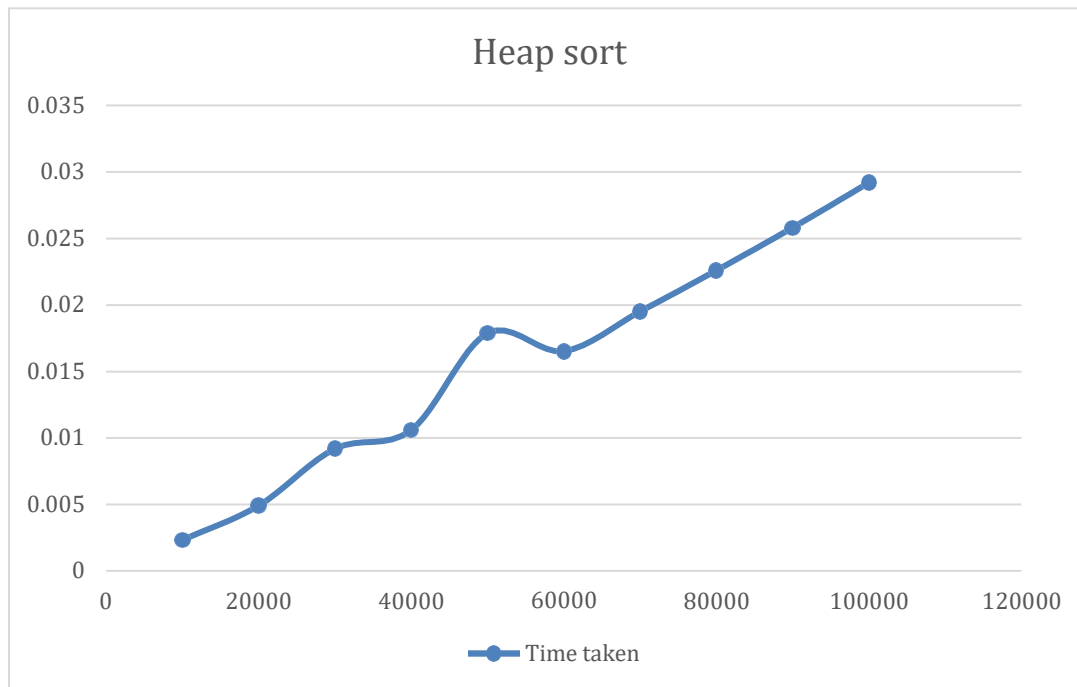
After sorting elements are
41      6334    18467    19169    26500

```

Table of values:

Input size(n)	Time taken
10000	0.002324
20000	0.004903
30000	0.009185
40000	0.010584
50000	0.017871
60000	0.016515
70000	0.019496
80000	0.022587
90000	0.025799
100000	0.029185

Graph:



Implement 0/1 Knapsack problem using dynamic programming.

```
#include<stdio.h>

void main()

{

    int i,j,w[10],p[10],opt[10][10],x[10],n,m;

    printf("Enter the number of items\n");

    scanf("%d",&n);

    printf("enter the weight and profit of each item\n");

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

    {

        scanf("%d %d",&w[i],&p[i]);

    }

    printf("enter the knapsack capacity\n");

    scanf("%d",&m);

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

    {

        for(j=0;j<=m;j++)

        {

            if(i==0 || j==0)

            {

                opt[i][j]=0;

            }

            else if(j-w[i]<0)

            {
```

```

        opt[i][j]=opt[i-1][j];
    }
    else
    {
        opt[i][j]=opt[i-1][j-w[i]]+p[i]>(opt[i-1][j])?opt[i-1][j-w[i]]+p[i):(opt[i-1][j]);
    }
}
}

//output
printf("\nknapsack table\n");
for(i=0;i<=n;i++)
{
    for(j=0;j<=m;j++)
    {
        printf("%d\t",opt[i][j]);
    }
    printf("\n");
}
for(i=n;i>=1;i--)
{
    if(opt[i][m]!=opt[i-1][m])
    {
        x[i]=1;
        m=m-w[i];
    }
}

```

```

    }

    else

    {

        x[i]=0;

    }

}

printf("\nitems selected are designated 1\n");

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

{

    printf("%d ",x[i]);

}

}

```

Output:

```

Enter the number of items
4
enter the weight and profit of each item
2 12
1 10
3 20
2 15
enter the knapsack capacity
5

knapsack table
0      0      0      0      0      0
0      0      12     12     12     12
0      10     12     22     22     22
0      10     12     22     30     32
0      10     15     25     30     37

items selected are designated 1
1 1 0 1

```

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

```
#include<stdio.h>

void main()
{
    int adj[10][10],n,i,j,k;
    int result[10][10];

    printf("Floyd's algorithm\n");
    printf("enter the number of vertices\n");
    scanf("%d",&n);
    printf("Enter the distance matrix for %d vertices\n",n);
    for(i=0;i<n;i++)
    {
        for(j=0;j<n;j++)
        {
            scanf("%d",&adj[i][j]);
            result[i][j]=adj[i][j];
        }
    }
    for(k=0;k<n;k++)
    {
        for(j=0;j<n;j++)
        {
            for(i=0;i<n;i++)
            {
```



```

        result[i][j]=result[i][j]<(result[i][k]+result[k][j])?result[i][j]:(result[i][k]+result[k][j]);
    }
}
}

printf("\nResult\n");
for(i=0;i<n;i++)
{
    for(j=0;j<n;j++)
    {
        printf("%d\t",result[i][j]);
    }
    printf("\n");
}
}

```

Output:

```

Floyd's algorithm
enter the number of vertices
4
Enter the distance matrix for 4 vertices
0 999 3 999
2 0 999 999
999 7 0 1
6 999 999 0

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

```

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

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
5
enter the cost adjacency matrix
0 1 5 2 999
1 0 999 999 999
5 999 0 3 999
2 999 3 0 2
999 999 999 2 0
edges of spanning tree
1,2    1,4    4,5    4,3    weight=8

```

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

```


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 G[MAX][MAX], int n, int startnode);

int main()
{
    int G[MAX][MAX], i, j, n, u;

    printf("Enter no. of vertices:");

    scanf("%d", &n);

    printf("\nEnter the adjacency matrix:\n");

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

    printf("\nEnter the starting node:");

    scanf("%d", &u);

    dijkstra(G, n, u);

    return 0;
}

void dijkstra(int G[MAX][MAX], int n, int startnode)
{

```

```

int cost[MAX][MAX], distance[MAX], pred[MAX];

int visited[MAX], count, mindistance, nextnode, i, j;

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

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

        if (G[i][j] == 0)

            cost[i][j] = INFINITY;

        else

            cost[i][j] = G[i][j];

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

{

    distance[i] = cost[startnode][i];

    pred[i] = startnode;

    visited[i] = 0;

}

distance[startnode] = 0;

visited[startnode] = 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++;
    }

    for (i = 0; i < n; i++)
        if (i != startnode)
        {
            printf("\nDistance of node%d = %d", i, distance[i]);
            printf("\nPath = %d", i);
            j = i;
            do

```

```

    {
        j = pred[j];
        printf("<-%d", j);
    } while (j != startnode);
}
}

```

Output:

```

Enter no. of vertices:6

Enter the adjacency matrix:
0 25 100 35 9999 9999
9999 0 9999 27 14 9999
9999 9999 0 50 9999 48
9999 9999 9999 0 29 9999
9999 9999 9999 9999 0 21
9999 9999 48 9999 9999 0

Enter the starting node:0

Distance of node1 = 25
Path = 1<-0
Distance of node2 = 100
Path = 2<-0
Distance of node3 = 35
Path = 3<-0
Distance of node4 = 39
Path = 4<-1<-0
Distance of node5 = 60
Path = 5<-4<-1<-0

```

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;
}

// 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
    }
}

```

/*function to check conflicts

If no conflict for desired position returns 1 otherwise returns 0*/

```

int place(int row, int column)

```

```

{
    int i;
    for (i = 1; i <= row - 1; ++i)
    {
        // checking column and diagonal 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:

- 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	-	-