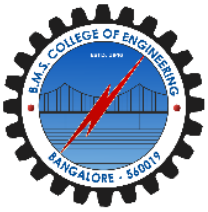
B.M.S. COLLEGE OF ENGINEERING
Basavanagudi, Bengaluru- 560019
DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING



LAB REPORT

On

Analysis and Design of Algorithms

(23CS4PCADA)

Submitted By:

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1BM22CS027

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CERTIFICATE

This is to certify that the Lab work entitled "Analysis and Design of Algorithms (23CS4PCADA)" conducted by **Akanksha Singa (1BM22CS027),** who is bonafide student at **B.M.S.College of Engineering**. It is in partial fulfilment for the award of **Bachelor of Engineering in Computer Science and Engineering** during the academic year 2023-24. The Lab report has been approved as it satisfies the academic requirements in respect of a Analysis and Design of Algorithms (23CS4PCADA) work prescribed for the said degree.

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

```
//C program to implement topological sort using DFS
#include <stdio.h>
int n, a[10][10], res[10], s[10], top = 0;
void dfs(int, int, int[][10]);
void dfs_top(int, int[][10]);
int main()
{
printf("Enter the no. of nodes");
scanf("%d", &n);
int i, j;
for (i = 0; i < n; i++) {
for (j = 0; j < n; j++) {
scanf("%d", &a[i][j]);
}
}
dfs_top(n, a);
printf("Solution: ");
for (i = n - 1; i >= 0; i--) {
printf("%d ", res[i]);
}
return 0;
}
void dfs_top(int n, int a[][10]) {
int i;
for (i = 0; i < n; i++) {
s[i] = 0;
}
for (i = 0; i < n; i++) {
if (s[i] == 0) {
dfs(i, n, a);
}
}
}
void dfs(int j, int n, int a[][10]) {
s[j] = 1;
1
int i;
for (i = 0; i < n; i++) {
if (a[j][i] == 1 && s[i] == 0) {
dfs(i, n, a);
}
}
res[top++] = j;
}
```

OUTPUT:

```
Enter the no. of nodes6
0 0 1 1 0 0
0 0 0 1 1 0
0 0 0 1 0 1
0 0 0 0 0 1
0 0 0 0 0 1
0 0 0 0 0 0
Solution: 1 4 0 2 3 5
//C program to implement topological sort using source removal method
#include<stdio.h>
int a[10][10],n,t[10],indegree[10];
int stack[10],top=-1;
void computeIndegree(int,int [][10]);
void tps_SourceRemoval(int,int [][10]);
int main(){
printf("Enter the no. of nodes: ");
scanf("%d",&n);
int i,j;
for(i=0;i<n;i++){
for(j=0;j<n;j++){
scanf("%d",&a[i][j]);
}
}
computeIndegree(n,a);
tps_SourceRemoval(n,a);
printf("Solution:");
for(i=0;i<n;i++){
printf("%d ",t[i]);
}
return 0;
2
}
3


void computeIndegree(int n,int a[][10]){
   int i,j,sum=0;
   for(i=0;i<n;i++){
      sum=0;
      for(j=0;j<n;j++){
         sum=sum+a[j][i];
      }
      indegree[i]=sum;
   }
}

void tps_SourceRemoval(int n,int a[][10]){
   int i,j,v;
```

```
    for(i=0;i<n;i++){
        if(indegree[i]==0){
            stack[++top]=i;
        }
    }
    int k=0;
    while(top!=-1){
        v=stack[top--];
        t[k++]=v;
        for(i=0;i<n;i++){
            if(a[v][i]!=0){
                indegree[i]=indegree[i]-1;
                if(indegree[i]==0){
                    stack[++top]=i;
                }
            }
        }
    }
}
```

OUTPUT:

```
Enter the no. of nodes: 5
0 0 1 0 0
1 0 0 1 0
0 0 0 0 1
0 0 1 0 1
0 0 0 0 0
Solution:1 3 0 2 4
```

2. 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.

```
//C program to implement merge sort
#include <stdio.h>
#include<time.h>
int a[20],n;
void simple_sort(int [],int,int,int);
void merge_sort(int[],int,int);
int main()
{
}
int i;
clock_t start, end;
double time_taken;
printf("Enter the no. of elements:");
scanf("%d", &n);
printf("Enter the array elements:");
for (i = 0; i < n; i++) {
scanf("%d", &a[i]);
}
start = clock();
merge_sort(a, 0, n - 1);
end = clock();
time_taken = (double)(end - start) / CLOCKS_PER_SEC;
printf("Sorted array:");
for (i = 0; i < n; i++) {
printf("%d ", a[i]);
}
printf("\n");
printf("Time taken to sort: %f seconds\n", time_taken);
return 0;
void merge_sort(int a[],int low, int high){
if(low<high){
6
int mid=(low+high)/2;
merge_sort(a,low,mid);
merge_sort(a,mid+1,high);
simple_sort(a,low,mid,high);
}
}
void simple_sort(int a[],int low, int mid, int high){
int i=low,j=mid+1,k=low;
int c[n];
while(i<=mid && j<=high){
if(a[i]<a[j]){
c[k++]=a[i];
```

```
i++;
}else{
c[k++]=a[j];
j++;
}
}
while(i<=mid){
c[k++]=a[i];
i++;
}
while(j<=high){
c[k++]=a[j];
j++;
}
for(i=low;i<=high;i++){
a[i]=c[i];
}
}
```

OUTPUT:

```
Enter the no. of elements:10
Enter the array elements:8 96 32 75 62 78 63 48 56 100
Sorted array:8 32 48 56 62 63 75 78 96 100
Time taken to sort: 0.000002 seconds
```

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

```
//C program to implement quick sort
#include <stdio.h>
#include<time.h>
int a[20],n;
int partition(int [],int, int);
void quick_sort(int [],int,int);
void swap(int*,int*);
int main()
{
int i;
clock_t start, end;
double time_taken;
printf("Enter the no. of elements:");
scanf("%d", &n);
printf("Enter the array elements:");
for (i = 0; i < n; i++) {
scanf("%d", &a[i]);
}
start = clock();
quick_sort(a, 0, n - 1);
end = clock();
time_taken = (double)(end - start) / CLOCKS_PER_SEC;
printf("Sorted array:");
for (i = 0; i < n; i++) {
printf("%d ", a[i]);
}
printf("\n");
printf("Time taken to sort: %f seconds\n", time_taken);
return 0;
}
void swap(int *a,int *b){
int temp=*a;
8
*a=*b;
}
*b=temp;
void quick_sort(int a[],int low,int high){
if(low<high){
int mid=partition(a,low,high);
quick_sort(a,low,mid-1);
quick_sort(a,mid+1,high);
}
}
int partition(int a[],int low,int high){
int pivot=a[low];
```

```
int i=low;
int j=high+1;
while(i<=j){
do{
i=i+1;
}while(a[i]<pivot && i<=high);
do{
j=j-1;
}while(a[j]>pivot && j>=low);
if(i<j){
swap(&a[i],&a[j]);
}
}
swap(&a[j],&a[low]);
return j;
}
```

OUTPUT:

```
Enter the no. of elements:10
Enter the array elements:96 53 26 78 12 63 85 12 06 95
Sorted array:6 12 12 26 53 63 78 85 95 96
Time taken to sort: 0.000002 seconds
```

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

```
//C program to implement heapify
#include<stdio.h>
int a[10],n;
void heapify(int[],int);
int main(){
printf("Enter the number of array elements:");
scanf("%d",&n);
int i;
printf("Enter array elements:");
for(i=0;i<n;i++){
scanf("%d",&a[i]);
}
heapify(a,n);
printf("Array elements:");
for(i=0;i<n;i++){
printf(" %d",a[i]);
}
return 0;
}
void heapify(int a[],int n){
int k;
for(k=1;k<n;k++){
int key=a[k];
int c=k;
int p=(c-1)/2;
while(c>0 && key>a[p]){
a[c]=a[p];
c=p;
p=(c-1)/2;
}
a[c]=key;
}
}
```

OUTPUT:

```
Enter the number of array elements:7
Enter array elements:50 25 30 75 100 45 80
Array elements: 100 75 80 25 50 30 45
```

5. Implement 0/1 Knapsack problem using dynamic programming.
//C program to implement knapsack problem in dynamic programming

```
#include <stdio.h>
int n,m,w[10],p[10],v[10][10];
void knapsack(int,int,int[],int[]);
int max(int,int);
int main()
{
int i,j;
printf("Enter the no. of items:");
scanf("%d",&n);
printf("Enter the capacity of knapsack:");
scanf("%d",&m);
printf("Enter weights:");
for(i=0;i<n;i++){
scanf("%d",&w[i]);
}
printf("Enter profits:");
for(i=0;i<n;i++){
scanf("%d",&p[i]);
}
knapsack(n,m,w,p);
printf("Optimal Solution:\n");
for(i=0;i<n;i++){
for(j=0;j<n;j++){
printf("%d ",v[i][j]);
}
printf("\n");
}
return 0;
}
void knapsack(int n, int m, int w[],int p[]){
int i,j;
for(i=0;i<n;i++){
for(j=0;j<m;j++){
if(i==0 || j==0){
v[i][j]=0;
}else if(w[i]>j){
v[i][j]=v[i-1][j];
}else{
v[i][j]=max(v[i-1][j],((v[i-1][j-w[i]])+p[i]));
11
}
}
}
}
int max(int a,int b){
```

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

OUTPUT:

```
Enter the no. of items:4
Enter the capacity of knapsack:5
Enter weights:2 1 3 2
Enter profits:12 10 20 15
Optimal Solution:
0 0 0 0
0 10 10 10
0 10 10 20
0 10 15 25
```

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

```
//C program to implement floyd's algorithm
#include <stdio.h>
int a[10][10],D[10][10],n;
void floyd(int [][10],int);
int min(int,int);
int main()
{
printf("Enter the no. of vertices:");
scanf("%d",&n);
printf("Enter the cost adjacency matrix:\n");
int i,j;
for(i=0;i<n;i++){
for(j=0;j<n;j++){
scanf("%d",&a[i][j]);
}
}
floyd(a,n);
printf("Distance Matrix:\n");
for(i=0;i<n;i++){
for(j=0;j<n;j++){
printf("%d ",D[i][j]);
}
printf("\n");
}
return 0;
}
void floyd(int a[][10],int n){
int i,j,k;
for(i=0;i<n;i++){
for(j=0;j<n;j++){
D[i][j]=a[i][j];
}
}
for(k=0;k<n;k++){
for(i=0;i<n;i++){
for(j=0;j<n;j++){
D[i][j]=min(D[i][j],(D[i][k]+D[k][j]));
}
}
13
}
14

   }
```

```
int min(int a,int b){
   if(a<b){
      return a;
   }else{
      return b;
   }
}
```

OUTPUT:
Enter the no. of vertices:4
Enter the cost adjacency matrix:
0 99 3 99
2 0 99 99
99 6 0 1
7 99 99 0
Distance Matrix:
0 9 3 4
2 0 5 6
8 6 0 1
7 16 10 0

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

```
//C program to implement prim's algorithm
#include <stdio.h>

int cost[10][10], n, t[10][2], sum;

void prims(int cost[10][10], int n);

int main() {
   int i, j;

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

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

   prims(cost, n);

   printf("Edges of the minimal spanning tree:\n");
   for (i = 0; i < n - 1; i++) {
      printf("(%d, %d) ", t[i][0], t[i][1]);
   }
   printf("\nSum of minimal spanning tree: %d\n", sum);

   return 0;
}

void prims(int cost[10][10], int n) {
   int i, j, u, v;
   int min, source;
   int p[10], d[10], s[10];

   min = 999;
   source = 0;

   // Initialize arrays
   for (i = 0; i < n; i++) {
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      d[i] = cost[source][i];
      s[i] = 0;
```

```
        p[i] = source;
    }

    s[source] = 1;
    sum = 0;
    int k = 0;

    // Find MST
    for (i = 0; i < n - 1; i++) {
        min = 999;
        u = -1;

        // Find the vertex with minimum distance to the MST
        for (j = 0; j < n; j++) {
            if (s[j] == 0 && d[j] < min) {
                min = d[j];
                u = j;
            }
        }

        if (u != -1) {
            // Add edge to MST
            t[k][0] = u;
            t[k][1] = p[u];
            k++;
            sum += cost[u][p[u]];
            s[u] = 1;

            // Update distances
            for (v = 0; v < n; v++) {
                if (s[v] == 0 && cost[u][v] < d[v]) {
                    d[v] = cost[u][v];
                    p[v] = u;
                }
            }
        }
    }
}
```

OUTPUT:

```
Enter the number of vertices: 4
Enter the cost adjacency matrix:
17
0 1 5 2
1 0 99 99
5 99 0 3
2 99 3 0
Edges of the minimal spanning tree:
```

(1, 0) (3, 0) (2, 3)
Sum of minimal spanning tree: 6

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

```
//C program to implement Kruskal's algorithm
#include <stdio.h>

int cost[10][10], n, t[10][2], sum;

void kruskal(int cost[10][10], int n);
int find(int parent[10], int i);

int main() {
   int i, j;

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

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

   kruskal(cost, n);

   printf("Edges of the minimal spanning tree:\n");
   for (i = 0; i < n - 1; i++) {
      printf("(%d, %d) ", t[i][0], t[i][1]);
   }
   printf("\nSum of minimal spanning tree: %d\n", sum);

   return 0;
}

void kruskal(int cost[10][10], int n) {
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   int min, u, v, count, k;
   int parent[10];

   k = 0;
   sum = 0;

   // Initialize parent array for Union-Find
   for (int i = 0; i < n; i++) {
```

```
        parent[i] = i;
    }

    count = 0;
    while (count < n - 1) {
        min = 999;
        u = -1;
        v = -1;

        // Find the minimum edge
        for (int i = 0; i < n; i++) {
            for (int j = 0; j < n; j++) {
                if (find(parent, i) != find(parent, j) && cost[i][j] < min) {
                    min = cost[i][j];
                    u = i;
                    v = j;
                }
            }
        }

        // Perform Union operation
        int root_u = find(parent, u);
        int root_v = find(parent, v);

        if (root_u != root_v) {
            parent[root_u] = root_v;
            t[k][0] = u;
            t[k][1] = v;
            sum += min;
            k++;
            count++;
        }
    }
}

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

OUTPUT:

```
Enter the number of vertices: 4
Enter the cost adjacency matrix:
0 1 5 2
1 0 99 99
5 99 0 3
2 99 3 0
Edges of the minimal spanning tree:
(1, 0) (3, 0) (2, 3)
Sum of minimal spanning tree: 6
```

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

```
// C program to implement Dijkstra's algorithm
#include <stdio.h>
int cost[10][10], n, result[10][2], weight[10];
void dijkstras(int [][10], int );
int main()
{
int i, j, s;
printf("Enter the number of vertices: ");
scanf("%d", &n);
printf("Enter the cost adjacency matrix:\n");
for (i = 0; i < n; i++) {
for (j = 0; j < n; j++) {
scanf("%d", &cost[i][j]);
}
}
printf("Enter the source vertex: ");
scanf("%d", &s);
dijkstras(cost, s);
printf("Path:\n");
for (i = 1; i < n; i++) {
printf("(%d, %d) with weight %d ", result[i][0], result[i][1], weight[result[i][1]]);
}
return 0;
}
void dijkstras(int cost[][10], int s){
int d[10], p[10], visited[10];
int i, j, min, u, v, k;
for(i = 0; i < 10; i++){
d[i] = 999;
visited[i] = 0;
p[i] = s;
}
d[s] = 0;
visited[s] = 1;
for(i = 0; i < n; i++){
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      min = 999;
      u = 0;
      for(j = 0; j < n; j++){
         if(visited[j] == 0){
            if(d[j] < min){
               min = d[j];
               u = j;
```

```
            }
        }
    }
    visited[u] = 1;

    for(v = 0; v < n; v++){
        if(visited[v] == 0 && (d[u] + cost[u][v] < d[v])){
            d[v] = d[u] + cost[u][v];
            p[v] = u;
        }
    }
  }
  for(i = 0; i < n; i++){
    result[i][0] = p[i];
    result[i][1] = i;
    weight[i] = d[i];
  }
}
```

OUTPUT:

```
Enter the number of vertices: 4
Enter the cost adjacency matrix:
0 1 5 2
1 0 99 99
5 99 0 3
2 99 3 0
Enter the source vertex: 0
Path:
(0, 1) with weight 1 (0, 2) with weight 5 (0, 3) with weight 2
```

9. Implement fractional Knapsack problem using Greedy technique.

```
#include <stdio.h>
void knapsack(int n, int p[], int w[], int W) {
int used[n];
for (int i = 0; i < n; ++i)
used[i] = 0;
int cur_w = W;
float tot_v = 0.0;
int i, maxi;
while (cur_w > 0) {
maxi = -1;
for (i = 0; i < n; ++i)
if ((used[i] == 0) &&
((maxi == -1) || ((float)w[i]/p[i] > (float)w[maxi]/p[maxi])))
maxi = i;
used[maxi] = 1;
if (w[maxi] <= cur_w) {
cur_w -= w[maxi];
tot_v += p[maxi];
printf("Added object %d (%d, %d) completely in the bag. Space left: %d.\n", maxi + 1,
w[maxi], p[maxi], cur_w);
} else {
int taken = cur_w;
cur_w = 0;
tot_v += (float)taken/p[maxi] * p[maxi];
printf("Added %d%% (%d, %d) of object %d in the bag.\n", (int)((float)taken/w[maxi] *
100), w[maxi], p[maxi], maxi + 1);
}
}
printf("Filled the bag with objects worth %.2f.\n", tot_v);
}
int main() {
int n, W;
printf("Enter the number of objects: ");
scanf("%d", &n);
int p[n], w[n];
printf("Enter the profits of the objects: ");
for(int i = 0; i < n; i++){
scanf("%d", &p[i]);
}
printf("Enter the weights of the objects: ");
for(int i = 0; i < n; i++){
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}
scanf("%d", &w[i]);
printf("Enter the maximum weight of the bag: ");
scanf("%d", &W);
```

```
knapsack(n, p, w, W);
return 0;
}
```
OUTPUT:
```
Enter the number of objects: 7
Enter the profits of the objects: 5 10 15 7 8 9 4
Enter the weights of the objects: 1 3 5 4 1 3 2
Enter the maximum weight of the bag: 15
Added object 4 (4, 7) completely in the bag. Space left: 11.
Added object 7 (2, 4) completely in the bag. Space left: 9.
Added object 3 (5, 15) completely in the bag. Space left: 4.
Added object 6 (3, 9) completely in the bag. Space left: 1.
Added 33% (3, 10) of object 2 in the bag.
Filled the bag with objects worth 36.00.
```

10. Implement “N-Queens Problem” using Backtracking.

```
#include <stdio.h>
#include <stdbool.h>
bool place(int[], int);
void printSolution(int[], int);
void nQueens(int);
int main()
{
int n;
printf("Enter the number of queens: ");
scanf("%d",&n);
nQueens(n);
return 0;
}
void nQueens(int n){
int x[10];
int count=0;
int k=1;
while(k!=0){
x[k]=x[k]+1;
while(x[k]<=n && !place(x,k)){
x[k]=x[k]+1;
}
if(x[k]<=n){
if(k==n){
printSolution(x, n);
printf("Solution found\n");
count++;
}else{
k++;
x[k]=0;
}
}else{
k--;
}
}
printf("Total solutions: %d\n", count);
}
bool place(int x[10], int k){
int i;
for(i=1;i<k;i++){
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if((x[i]==x[k])||(i-x[i]==k-x[k])||(i+x[i]==k+x[k])){
}
}
return false;
return true;
```

```
}
void printSolution(int x[10], int n){
int i;
for(i=1;i<=n;i++){
printf("%d ", x[i]);
}
printf("\n");
}
```

OUTPUT:

```
Enter the number of queens: 4
2 4 1 3
Solution found
3 1 4 2
Solution found
Total solutions: 2
```