**VISVESVARAYA TECHNOLOGICAL UNIVERSITY**

**“JnanaSangama”, Belgaum -590014, Karnataka.**

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**LAB REPORT**

**On**

**ANALYSIS AND DESIGN OF ALGORITHMS (23CS4PCADA)**

**Submitted by**

**Dhanush S (1BM23CS089)**

**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)**

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**B. M. S. College of Engineering,**

**Bull Temple Road, Bangalore 560019**

**(Affiliated To Visvesvaraya Technological University, Belgaum)**

**Department of Computer Science and Engineering**

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This is to certify that the Lab work entitled **“ANALYSIS AND DESIGN OF ALGORITHMS”** carried out by Dhanush S**(1BM23CS089)**, 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 year 2024-25. The Lab report has been approved as it satisfies the academic requirements in respect of Analysis and Design of Algorithms Lab - **(23CS4PCADA)** work prescribed for the said degree.

**Prof. Sowmya T** **Dr. Kavitha Sooda**

Assistant Professor Professor and Head

Department of CSE Department of CSE

BMSCE, Bengaluru BMSCE, Bengaluru

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**Course outcomes:**

|  |  |
| --- | --- |
| 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. |

**Lab program 1:**

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

i)using dfs

**CODE:**

#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;

int i;

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

if (a[j][i] == 1 & s[i] == 0) {

dfs(i, n, a);

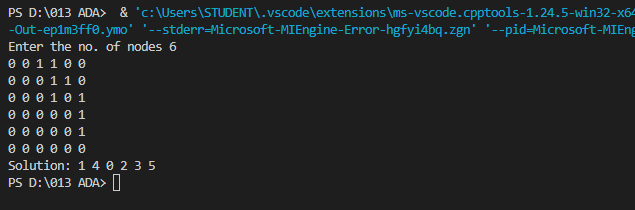
}

}

res[top++] = j;

}

**OUTPUT:**



ii) using source removal method

**CODE:**

#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;

}

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;

}

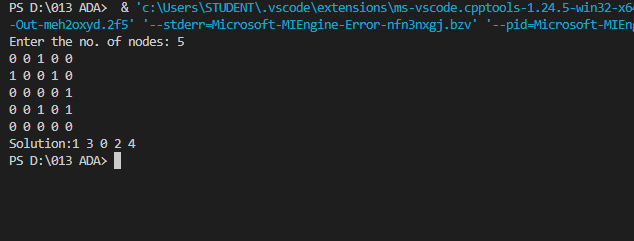
}

}

}

}

**OUTPUT:**



LeetCode Program related to Topological sorting

**CODE:**

bool dfs(int course, int\*\* prerequisites, int prerequisitesSize, int\* prerequisitesColSize, int\* visited, int

numCourses) {

if (visited[course] == 1) {

return false;

}

if (visited[course] == 2) {

return true;

}

visited[course] = 1;

for (int i = 0; i < prerequisitesSize; i++) {

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if (prerequisites[i][0] == course) {

int nextCourse = prerequisites[i][1];

if (!dfs(nextCourse, prerequisites, prerequisitesSize, prerequisitesColSize, visited, numCourses)) {

return false;

}

}

}

visited[course] = 2;

return true;

}

bool canFinish(int numCourses, int\*\* prerequisites, int prerequisitesSize, int\* prerequisitesColSize) {

int visited[numCourses];

for (int i = 0; i < numCourses; i++) {

visited[i] = 0;

}

for (int i = 0; i < numCourses; i++) {

if (visited[i] == 0) {

if (!dfs(i, prerequisites,prerequisitesSize, prerequisitesColSize, visited, numCourses)) {

return false;

}

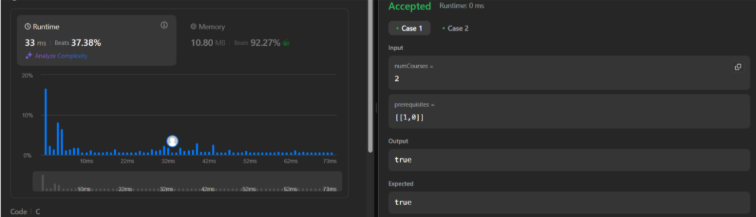
}

}

return true;

}

**OUTPUT:**

****

**Lab program 2:**

Implement Johnson Trotter algorithm to generate permutations.

**CODE:**

#include <stdio.h>

#include <stdlib.h>

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

int temp = \*a;

\*a = \*b;

\*b = temp;

}

void generatePermutations(int arr[], int start, int end) {

if (start == end) {

for (int i = 0; i <= end; i++) {

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

}

printf("\n");

} else {

for (int i = start; i <= end; i++) {

swap(&arr[start], &arr[i]);

generatePermutations(arr, start + 1, end);

swap(&arr[start], &arr[i]); // backtrack

}

}

}

int main() {

int n;

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

scanf("%d", &n);

int\* arr = (int\*)malloc(n \* sizeof(int));

printf("Enter the elements: ");

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

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

}

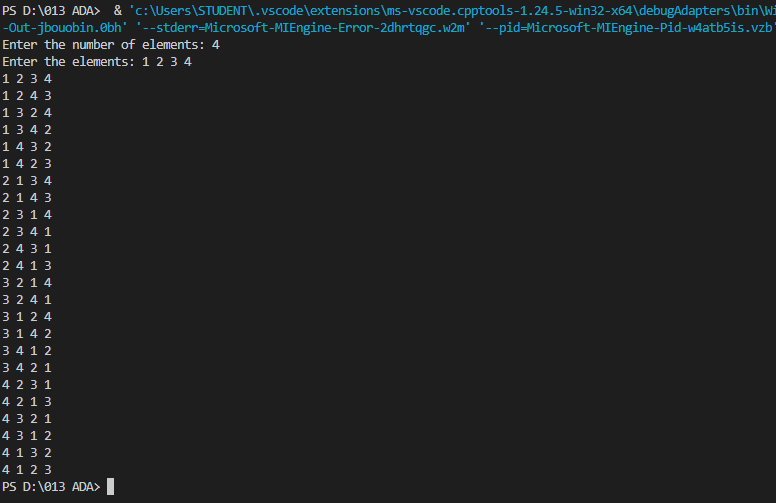
generatePermutations(arr, 0, n - 1);

free(arr);

return 0;

}

**OUTPUT:**



**Lab program 3:**

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.

**CODE:**

#include<stdio.h>

#include<time.h>

int a[20],n;

void simple\_sort(int [],int,int,int);

void merge\_sort(int a[],int low, int high){

if(low<high){

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];

}

}

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]);

}

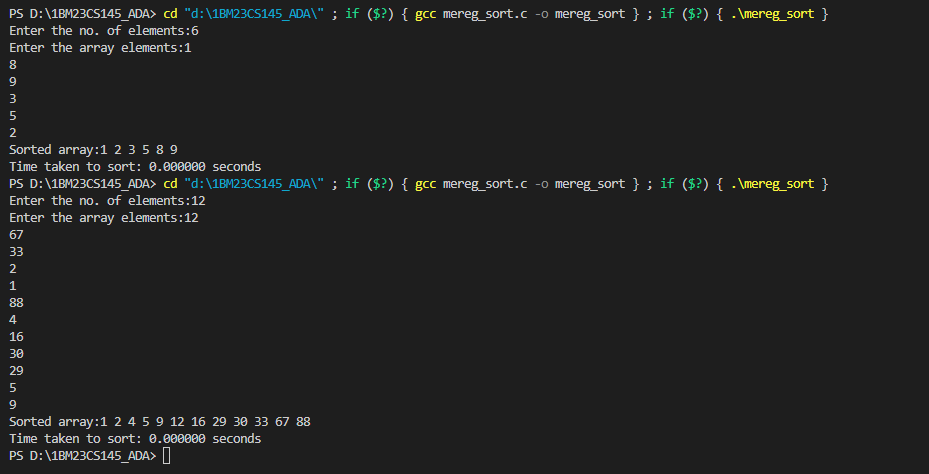
printf("\n");

printf("Time taken to sort: %f seconds\n", time\_taken);

return 0;

}

**OUTPUT:**



**Lab program 4:**

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

**CODE:**

#include <stdio.h>

#include <stdlib.h> // for rand()

#include <time.h> // for clock()

#define MAX 5000

void quicksort(int[], int, int);

int partition(int[], int, int);

int main() {

int i, n, a[MAX], ch;

clock\_t start, end;

while (1) {

printf("\nEnter the number of elements: ");

scanf("%d", &n);

// Generate random array elements

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

a[i] = rand() % 200; // Random number between 0 and 199

}

// Display the random array

printf("The random generated array is:\n");

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

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

}

printf("\n");

// Measure the time taken for sorting

start = clock();

quicksort(a, 0, n - 1);

end = clock();

// Display the sorted array

printf("\nThe sorted array elements are:\n");

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

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

}

printf("\n");

// Calculate and print the time taken for sorting

printf("Time taken = %f seconds\n", (double)(end - start) / CLOCKS\_PER\_SEC);

// Ask user if they want to continue

printf("\nDo you wish to continue? (0/1): ");

scanf("%d", &ch);

if (ch == 0) {

break;

}

}

return 0;

}

// QuickSort function

void quicksort(int a[], int low, int high) {

if (low < high) {

int mid = partition(a, low, high);

quicksort(a, low, mid - 1); // Recursively sort the left part

quicksort(a, mid + 1, high); // Recursively sort the right part

}

}

// Partition function: Returns the partition index

int partition(int a[], int low, int high) {

int pivot = a[low]; // Pivot is the first element in the array

int i = low + 1;

int j = high;

int temp;

while (i <= j) {

// Find an element greater than the pivot

while (i <= high && a[i] <= pivot) {

i++;

}

// Find an element less than the pivot

while (a[j] > pivot) {

j--;

}

// If there are elements to swap, swap them

if (i < j) {

temp = a[i];

a[i] = a[j];

a[j] = temp;

}

}

// Swap the pivot element with a[j]

temp = a[low];

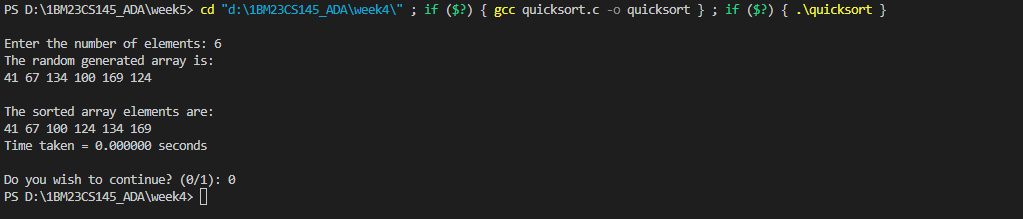
a[low] = a[j];

a[j] = temp;

return j; // Return the partition index

}

**OUTPUT:**



**Lab program 5:**

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

**CODE:**

#include<stdio.h>

#include<conio.h>

#include<time.h>

void heapcom(int a[],int n)

{

int i,j,k,item;

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

{

item=a[i];

j=i;

k=j/2;

while(k!=0 && item>a[k])

{

a[j]=a[k];

j=k;

k=j/2;

}

a[j]=item;

}

}

void adjust(int a[],int n)

{

int item,i,j;

j=1;

item=a[j];

i=2\*j;

while(i<n)

{

if((i+1)<n)

{

if(a[i]<a[i+1])

i++;

}

if(item<a[i])

{

a[j]=a[i];

j=i;

i=2\*j;

}

else

break;

}

a[j]=item;

}

void heapsort(int a[],int n)

{

int i,temp;

heapcom(a,n);

for(i=n;i>=1;i--)

{

temp=a[1];

a[1]=a[i];

a[i]=temp;

adjust(a,i);

}

}

void main()

{

int i,n,a[20],ch=1;

clock\_t start,end;

while(ch)

{

printf("\n enter the number of elements to sort\n");

scanf("%d",&n);

printf("\n enter the elements to sort\n");

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

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

start=clock();

heapsort(a,n);

end=clock();

printf("\n the sorted list of elemnts is\n");

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

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

printf("\n Time taken is %lf CPU cycles\n",(end-start)/CLK\_TCK);

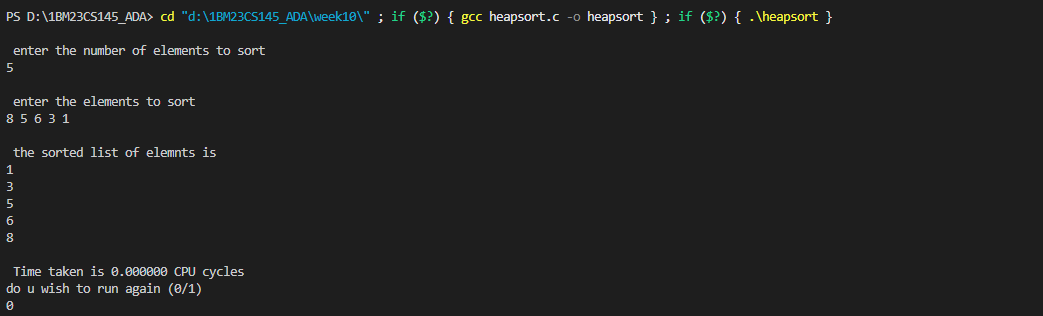
printf("do u wish to run again (0/1)\n");

scanf("%d",&ch);

}

}

**OUTPUT:**



**Lab program 6:**

Implement 0/1 Knapsack problem using dynamic programming.

**CODE**:

#include<stdio.h>

int i,j,n,c,w[10],p[10],v[10][10];

void knapsack(int n,int w[10],int p[10],int c)

{

int max(int,int);

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

{

for(j=0;j<=c;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]));

}

}

printf("\n\n Maximum Profit is : %d ",v[n][c]);

printf("\n\n\n Table : \n\n");

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

{

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

{

printf("\t%d",v[i][j]);

}

printf("\n");

}

}

int max(int a,int b)

{

return ((a>b)?a:b);

}

void main()

{

printf("\n Enter the no. of objects : ");

scanf("%d",&n);

printf("\n Enter the weights : ");

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

{

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

}

printf("\n Enter the Profits : ");

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

{

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

}

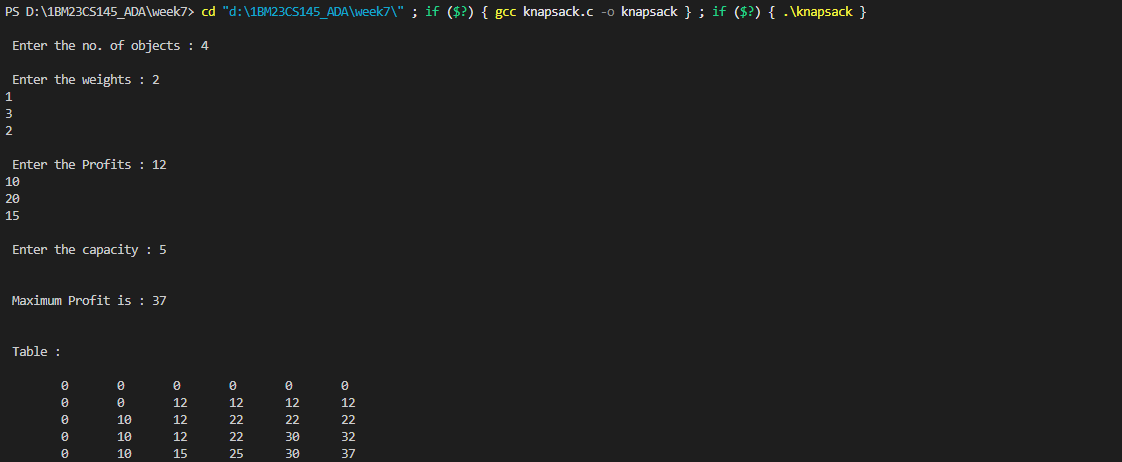
printf("\n Enter the capacity : ");

scanf("%d",&c);

knapsack(n,w,p,c);

}

**OUTPUT:**



LeetCode Program related to Knapsack problem or Dynamic Programming.

**CODE:**

class Solution(object):

def fib(self, n):

if n == 0:

return 0

if n == 1:

return 1

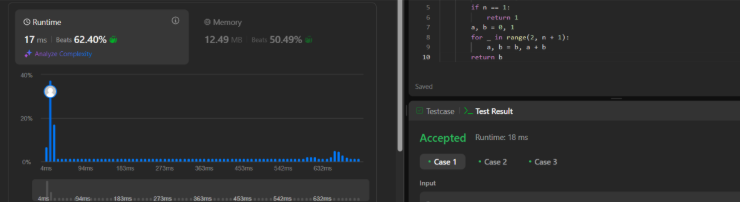
a, b = 0, 1

for \_ in range(2, n + 1):

a, b = b, a + b

return b

**OUTPUT:**

****

**Lab program 7:**

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

**CODE:**

#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]));

}

}

}

}

int min(int a,int b){

if(a<b){

return a;

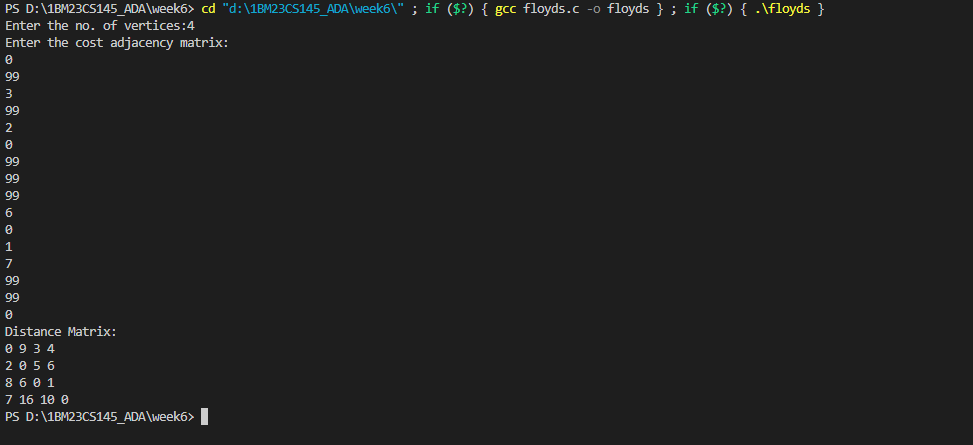
}else{

return b;

}

}

**OUTPUT:**



LeetCode Program related to shortest distance calculation.

**CODE:**

class Solution:

def shortestPathLength(self, graph: List[List[int]]) -> int:

n=len(graph)

queue=deque([(i,1<<i) for i in range(n)])

seen=set(queue)

ans=0

while queue:

for \_ in range(len(queue)):

u,m=queue.popleft()

if m==(1<<n)-1:

return ans

for v in graph[u]:

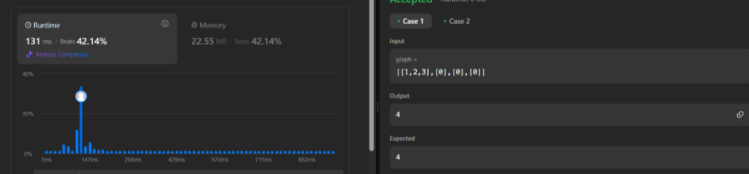
if (v,m|1<<v) not in seen:

queue.append((v,m|1<<v))

seen.add((v,m|1<<v))

ans+=1

**OUTPUT:**

****

**Lab program 8:**

Find Minimum Cost Spanning Tree of a given undirected graph using Prim’s algorithm.

**CODE:**

#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;

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

d[i] = cost[source][i];

s[i] = 0;

p[i] = source;

}

s[source] = 1;

sum = 0;

int k = 0;

for (i = 0; i <n - 1; i++) {

min = 999;

u = -1;

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

if (s[j] == 0 && d[j] <min) {

min = d[j];

u = j;

}

}

if (u != -1) {

t[k][0] = u;

t[k][1] = p[u];

k++;

sum += cost[u][p[u]];

s[u] = 1;

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

if (s[v] == 0 && cost[u][v] <d[v]) {

d[v] = cost[u][v];

p[v] = u;

}

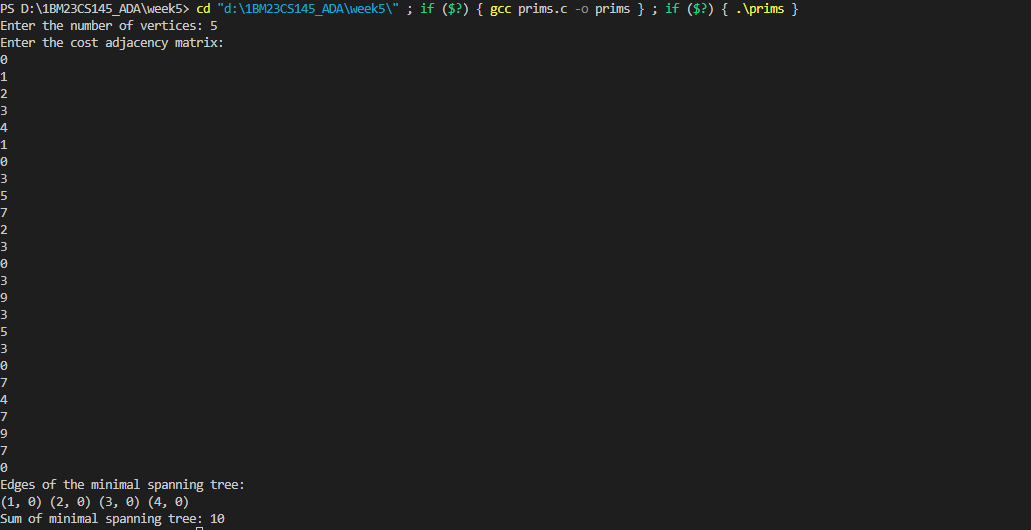
}

}

}

}

**OUTPUT:**



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

**CODE:**

#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) {

int min, u, v, count, k;

int parent[10];

k = 0;

sum = 0;

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

parent[i] = i;

}

count = 0;

while (count < n - 1) {

min = 999;

u = -1;

v = -1;

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;

}

}

}

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) {

while (parent[i] != i) {

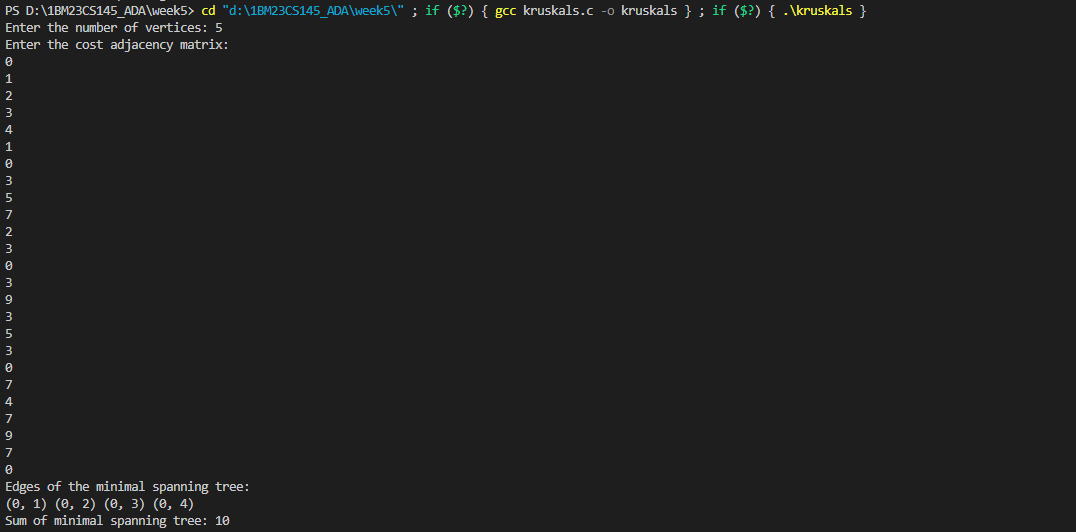
i = parent[i];

}

return i;

}

**OUTPUT:**



**Lab program 9:**

Implement Fractional Knapsack using Greedy technique.

**CODE**:

#include <stdio.h>

#define MAX 100

void fractionalKnapsack(int n, float weight[], float profit[], float capacity) {

float ratio[MAX],

temp; int i, j;

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

ratio[i] = profit[i] / weight[i];

for (i = 0; i < n - 1; i++) {

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

if (ratio[i] < ratio[j]) {

temp = ratio[i]; ratio[i] = ratio[j]; ratio[j] = temp;

temp = weight[i]; weight[i] = weight[j]; weight[j] = temp;

temp = profit[i]; profit[i] = profit[j]; profit[j] = temp;

}

}

}

float totalProfit = 0;

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

if (capacity >= weight[i]) {

capacity -= weight[i];

totalProfit += profit[i];

} else {

totalProfit += ratio[i] \* capacity;

break;

}

}

printf("Total Profit = %.2f\n", totalProfit);

}

int main() {

int n;

float weight[MAX], profit[MAX], capacity;

printf("Enter the number of items: ");

scanf("%d", &n);

printf("Enter the weights of the items: ");

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

scanf("%f", &weight[i]);

}

printf("Enter the profits of the items: ");

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

scanf("%f", &profit[i]);

}

printf("Enter the capacity of the knapsack: ");

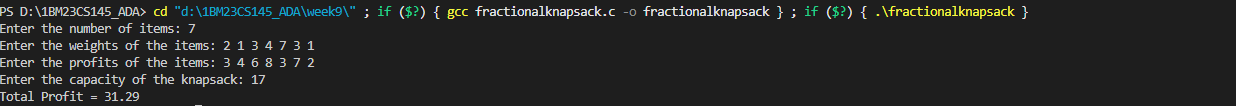
scanf("%f", &capacity);

fractionalKnapsack(n, weight, profit, capacity);

return 0;

}

**OTUPUT**:



LeetCode Program related to Greedy Technique algorithms.

**CODE:**

char\* largestOddNumber(char\* num) {

int len = strlen(num);

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for (int i = len - 1; i >= 0; i--) {

if ((num[i] - '0') % 2 == 1) {

num[i + 1] = '\0'; // Truncate string at that position

return num; // Return the longest odd-suffix (greedy)

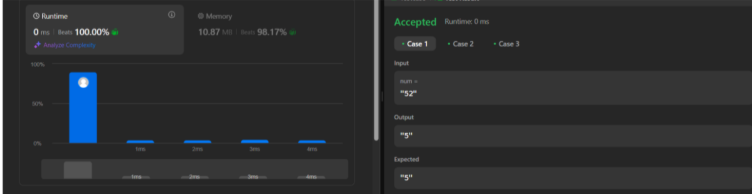
}

}

return ""; // No odd digit found

}

**OUTPUT:**

****

**Lab program 10:**

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

**CODE:**

#include<stdio.h>

void main()

{

int i,j,n,v,k,min,u,c[20][20],s[20],d[20];

printf("\n Enter the no. of vertices : ");

scanf("%d",&n);

printf("\n Enter the cost adjacency matrix : ");

printf("\n Enter 999 for no edge ");

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

{

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

{

scanf("%d",&c[i][j]);

}

}

printf("\n Enter the source vertex : ");

scanf("%d",&v);

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

{

s[i]=0;

d[i]=c[v][i];

}

d[v]=0;

s[v]=1;

for(k=2;k<=n;k++)

{

min=999;

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

if((s[i]==0)&(d[i]<min)){

min=d[i];

u=i;

}

}

s[u]=1;

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

{

if(s[i]==0)

{

if(d[i]>(d[u]+c[u][i]))

{

d[i]=d[u]+c[u][i];

}

}

}

}

printf("\n The shortest distance from %d is ",v);

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

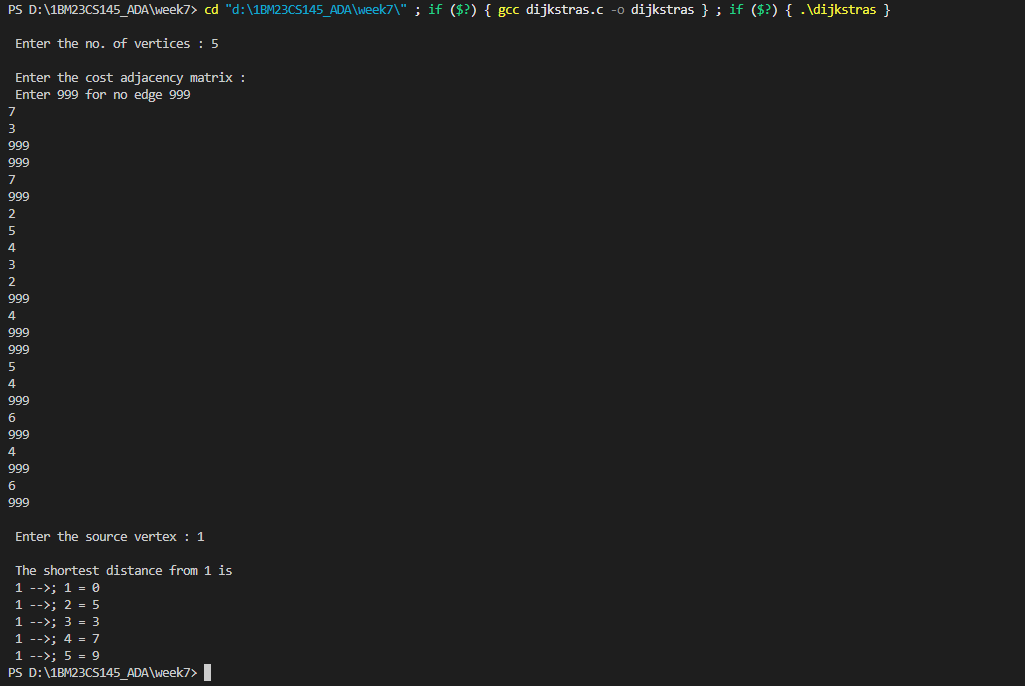
{

printf("\n %d -->; %d = %d ",v,i,d[i]);

}

}

**OUTPUT:**



**Lab program 11:**

Implement “N-Queens Problem” using Backtracking.

**CODE:**

#include<stdio.h>

#include<conio.h>

#include<math.h>

int x[20],count=1;

void queens(int,int);

int place(int,int);

void main()

{

int n,k=1;

printf("\n enter the number of queens to be placed\n");

scanf("%d",&n);

queens(k,n);

}

void queens(int k,int n)

{

int i,j;

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

{

if(place(k,j))

{

x[k]=j;

if(k==n)

{

printf("\n %d solution",count);

count++;

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

printf("\n \t %d row <---> %d column",i,x[i]);

getch();

}

else

queens(k+1,n);

}

}

}

int place(int k,int j)

{

int i;

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

if((x[i]==j) || (abs(x[i]-j))==abs(i-k))

return 0;

return 1;

}

**OUTPUT:**

