VISVESVARAYA TECHNOLOGICAL UNIVERSITY

"JnanaSangama", Belgaum -590014, Karnataka.

LAB REPORT
On

ANALYSIS AND DESIGN OF ALGORITHMS (23CS4PCADA)

Submitted by

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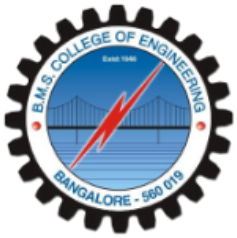
(1BM23CS266)

in partial fulfilment 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

This is to certify that the Lab work entitled **"ANALYSIS AND DESIGN OF ALGORITHMS"** carried out by RIDHIMA SUHANE **(1BM23CS266)**, who is bonafide student of **B. M. S. College of Engineering**. It is in partial fulfilment 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.

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Index Sheet

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.

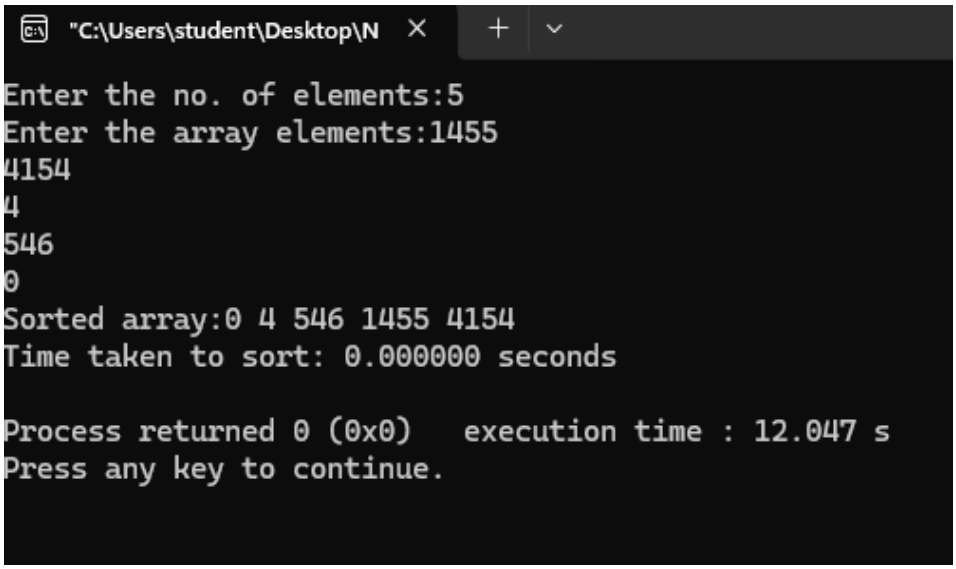
Lab program 1

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

```
#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)
   {
      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-



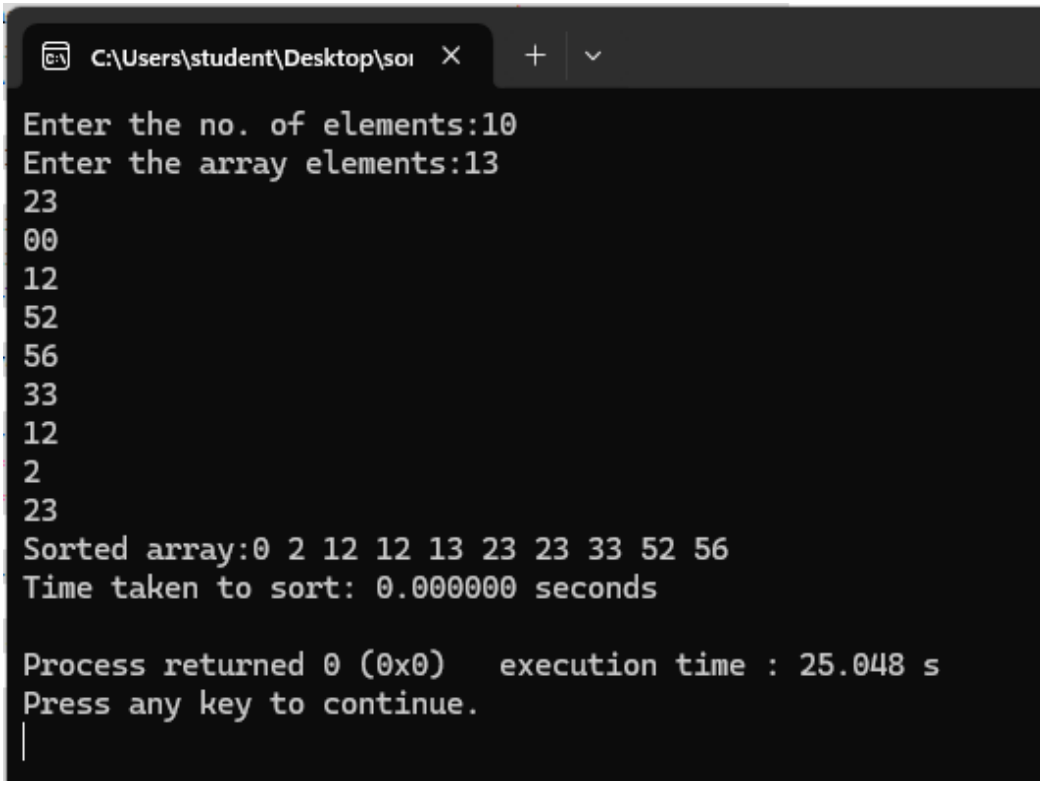
Sort a given set of N integer elements using Quick Sort technique and compute its time taken.

```
#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;
    *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-



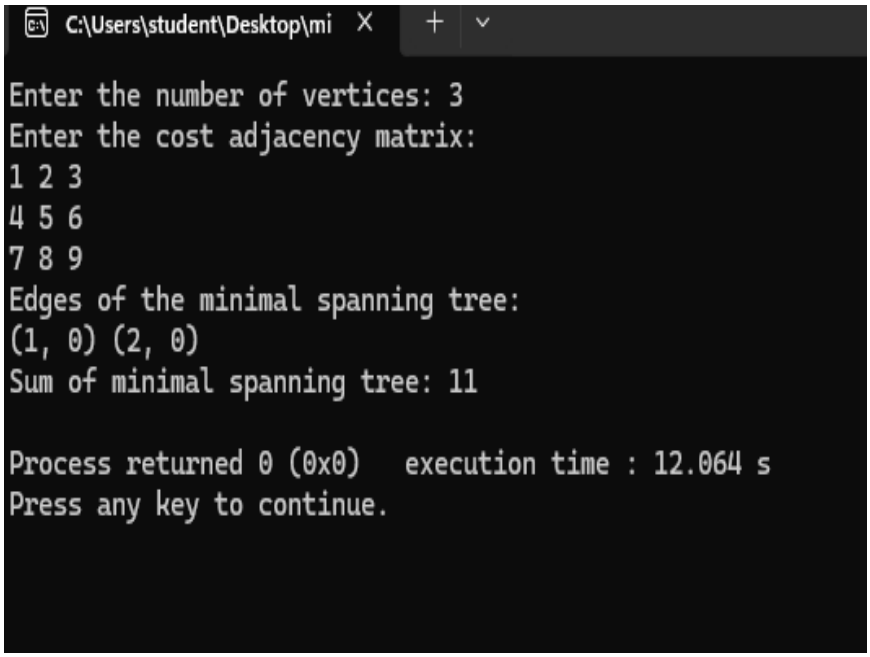
Lab program 2

Find Minimum Cost Spanning Tree of a given undirected graph using 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;
   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-



Lab program 3

Find Minimum Cost Spanning Tree of a given undirected graph using 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)
{
   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-

```
Enter the number of vertices: 4
Enter the cost adjacency matrix:
1 2 3 4
5 6 7 8
4 3 2 1
8 7 6 5
Edges of the minimal spanning tree:
(2, 3) (0, 1) (0, 2)
Sum of minimal spanning tree: 6

Process returned 0 (0x0)   execution time : 20.104 s
Press any key to continue.
```

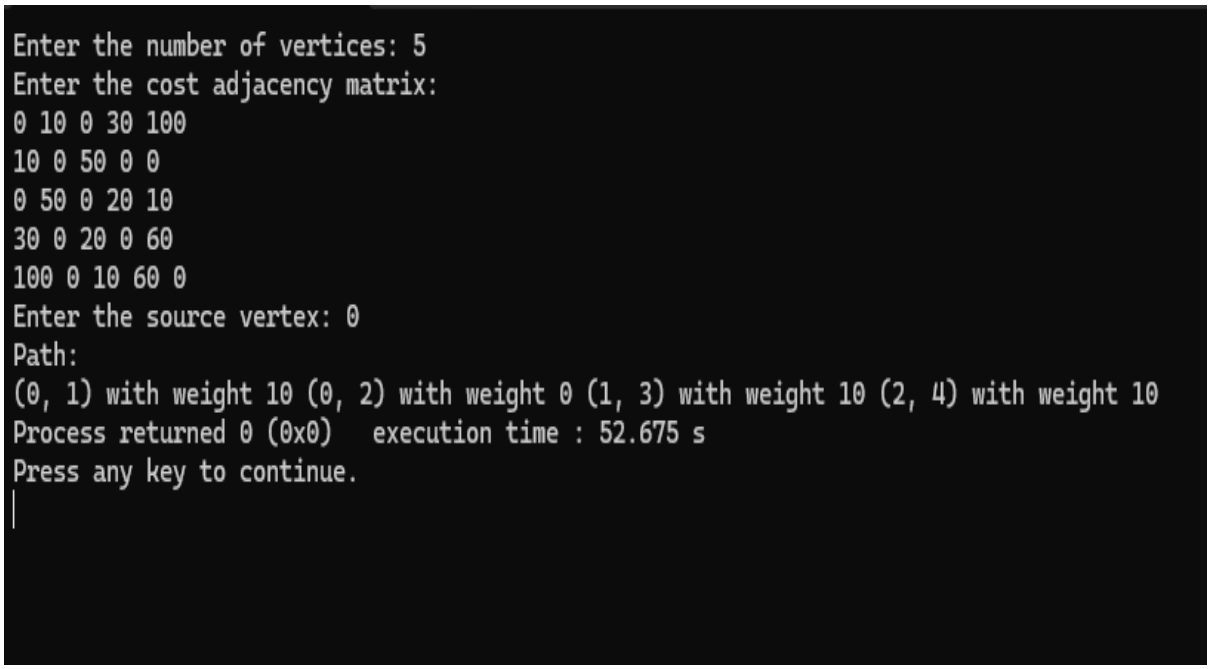
Lab program 4

From a given vertex in a weighted connected graph, find shortest paths to other vertices using 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++)
   {
      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-



Lab program 5

Leetcode (minimum height trees and maximum binary trees)

310. Minimum Height Trees

Medium | Topics | Companies | Hint

A tree is an undirected graph in which any two vertices are connected by *exactly* one path. In other words, any connected graph without simple cycles is a tree.

Given a tree of `n` nodes labelled from `0` to `n - 1`, and an array of `n - 1` `edges` where `edges[i] = [a_i, b_i]` indicates that there is an undirected edge between the two nodes `a_i` and `b_i` in the tree, you can choose any node of the tree as the root. When you select a node `x` as the root, the result tree has height `h`. Among all possible rooted trees, those with minimum height (i.e. `min(h)`) are called **minimum height trees** (MHTs).

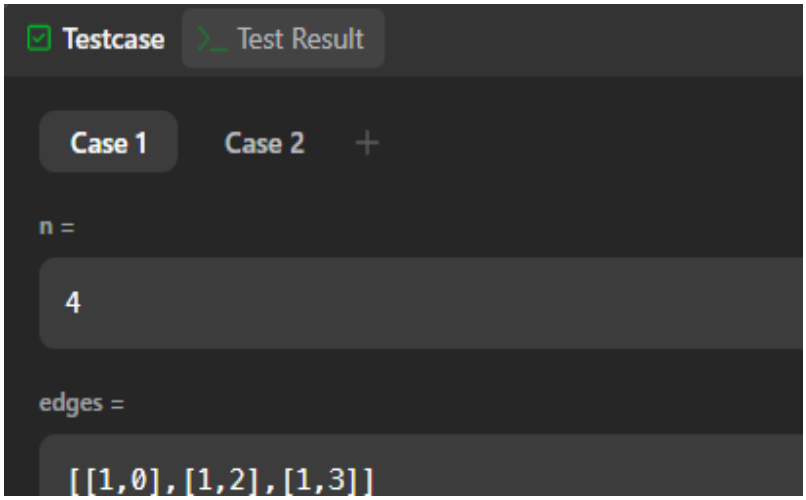
Return *a list of all **MHTs'** root labels*. You can return the answer in **any order**.

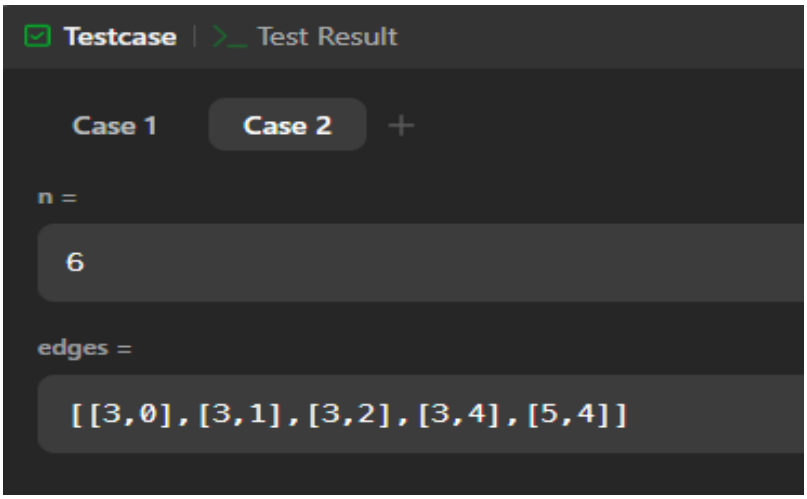
The **height** of a rooted tree is the number of edges on the longest downward path between the root and a leaf.

```
#include <stdlib.h>
#define MAX_N 20000

int* findMinHeightTrees(int n, int** edges, int edgesSize, int* edgesColSize, int* returnSize) {
    if (n == 1) {
        int* res = (int*)malloc(sizeof(int));
        res[0] = 0;
        *returnSize = 1;
        return res;
    }

    int* graph[MAX_N];
    int graphSize[MAX_N] = {0};
    int degree[MAX_N] = {0};

    for (int i = 0; i < n; i++) {
        graph[i] = (int*)malloc(sizeof(int) * MAX_N);
    }

    for (int i = 0; i < edgesSize; i++) {
        int u = edges[i][0];
        int v = edges[i][1];
        graph[u][graphSize[u]++] = v;
        graph[v][graphSize[v]++] = u;
        degree[u]++;
        degree[v]++;
    }

    int* leaves = (int*)malloc(sizeof(int) * n);
    int front = 0, back = 0;
    for (int i = 0; i < n; i++) {
        if (degree[i] == 1) {
            leaves[back++] = i;
        }
    }
    int remainingNodes = n;
    while (remainingNodes > 2) {
        int leavesCount = back - front;
        remainingNodes -= leavesCount;
        for (int i = 0; i < leavesCount; i++) {
```

```
            int leaf = leaves[front++];
            for (int j = 0; j < graphSize[leaf]; j++) {
                int neighbor = graph[leaf][j];
                degree[neighbor]--;
                if (degree[neighbor] == 1) {
                    leaves[back++] = neighbor;
                }
            }
        }
    }
    *returnSize = back - front;
    int* result = (int*)malloc(sizeof(int) * (*returnSize));
    for (int i = 0; i < *returnSize; i++) {
        result[i] = leaves[front++];
    }
    for (int i = 0; i < n; i++) {
        free(graph[i]);
    }
    free(leaves);
    return result;
}
```

OUTPUT-





654. Maximum Binary Tree

Medium | Topics | Companies

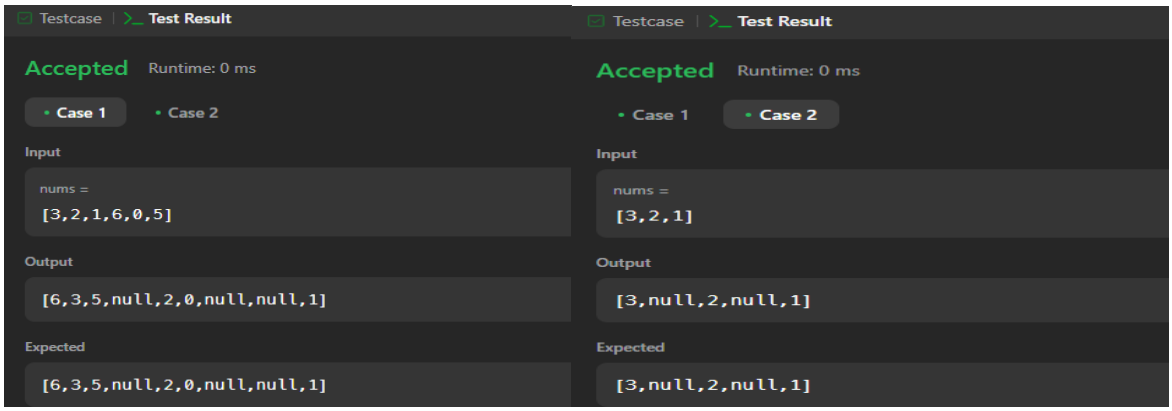
You are given an integer array `nums` with no duplicates. A **maximum binary tree** can be built recursively from `nums` using the following algorithm:

1. Create a root node whose value is the maximum value in `nums`.
2. Recursively build the left subtree on the **subarray prefix** to the **left** of the maximum value.
3. Recursively build the right subtree on the **subarray suffix** to the **right** of the maximum value.

Return *the **maximum binary tree** built from* `nums`.

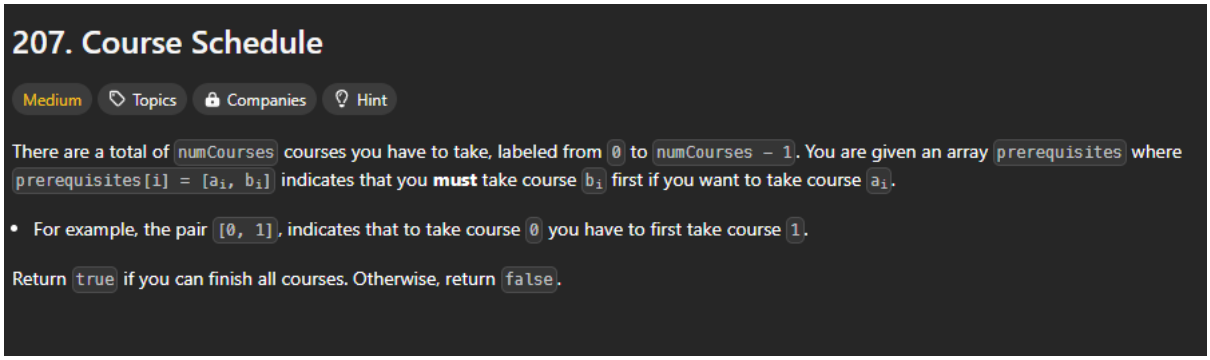
```
struct TreeNode* constructMaximumBinaryTree(int* nums, int numsSize){
    int max = -1, idx = -1;
    for (int i = 0; i < numsSize; i++){
        if (nums[i] > max){
            max = nums[i];
            idx = i;
        }
    }
    int size1 = idx;
    int size2 = numsSize - idx - 1;
    int * pref = nums;
    int * suff = nums + idx + 1;
    struct TreeNode * root = malloc(sizeof(struct TreeNode));
    root->val = max;
    if (size1 != 0){
        root->left = constructMaximumBinaryTree(pref, size1);
    }
    else root->left = NULL;
    if (size2 != 0){
        root->right = constructMaximumBinaryTree(suff, size2);
    }
    else root->right = NULL;
    return root;
}
```

OUTPUT-



Lab program 6

Leetcode (Topological sorting)



207. Course Schedule

Medium | Topics | Companies | Hint

There are a total of `numCourses` courses you have to take, labeled from `0` to `numCourses - 1`. You are given an array `prerequisites` where `prerequisites[i] = [a_i, b_i]` indicates that you **must** take course `b_i` first if you want to take course `a_i`.

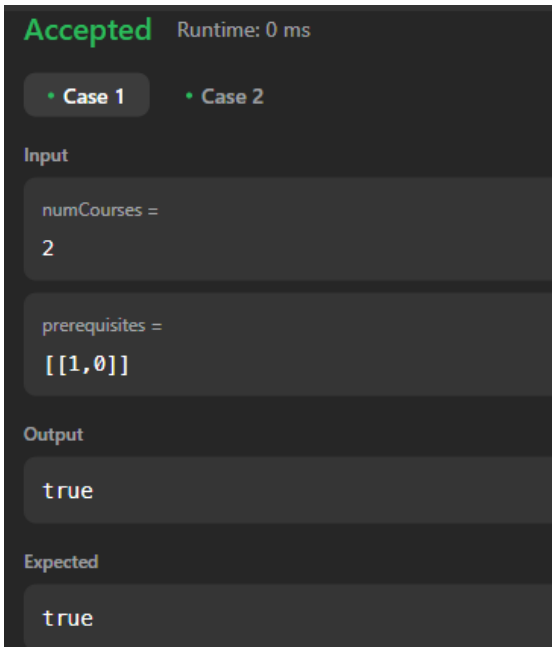
- For example, the pair `[0, 1]`, indicates that to take course `0` you have to first take course `1`.

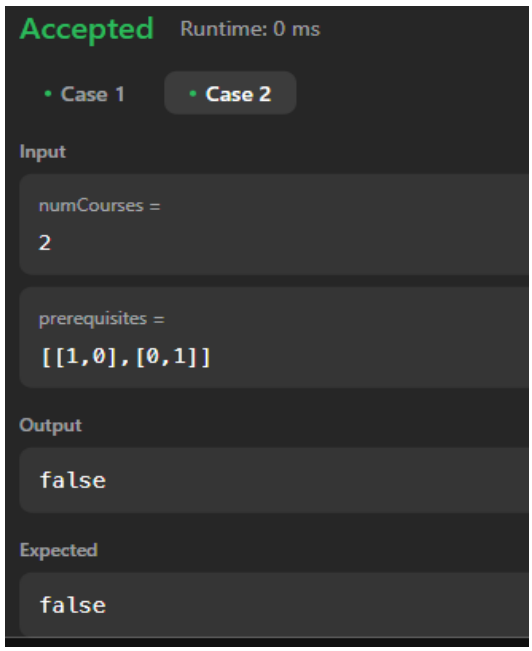
Return `true` if you can finish all courses. Otherwise, return `false`.

```
#include <stdio.h>
#include <stdlib.h>
#define MAX_COURSES 10000

bool canFinish(int numCourses, int** prerequisites, int prerequisitesSize, int* prerequisitesColSize) {
    int* inDegree = (int*)calloc(numCourses, sizeof(int));
    int** graph = (int**)malloc(numCourses * sizeof(int*));
    int* graphSize = (int*)calloc(numCourses, sizeof(int));

    for (int i = 0; i < numCourses; i++) {
        graph[i] = (int*)malloc(MAX_COURSES * sizeof(int))
    }
    for (int i = 0; i < prerequisitesSize; i++) {
        int course = prerequisites[i][0];
        int prereq = prerequisites[i][1];
        graph[prereq][graphSize[prereq]++] = course;
        inDegree[course]++;
    }
    int* queue = (int*)malloc(numCourses * sizeof(int));
    int front = 0, rear = 0;
    for (int i = 0; i < numCourses; i++) {
        if (inDegree[i] == 0) {
            queue[rear++] = i;
        }
    }
    int count = 0;
    while (front < rear) {
        int course = queue[front++];
        count++;
        for (int i = 0; i < graphSize[course]; i++) {
            int neighbor = graph[course][i];
            inDegree[neighbor]--;
            if (inDegree[neighbor] == 0) {
                queue[rear++] = neighbor;
            }
```

```
        }
    }

    for (int i = 0; i < numCourses; i++) {
        free(graph[i]);
    }
    free(graph);
    free(graphSize);
    free(inDegree);
    free(queue);

    return count == numCourses;
}
```

OUTPUT-

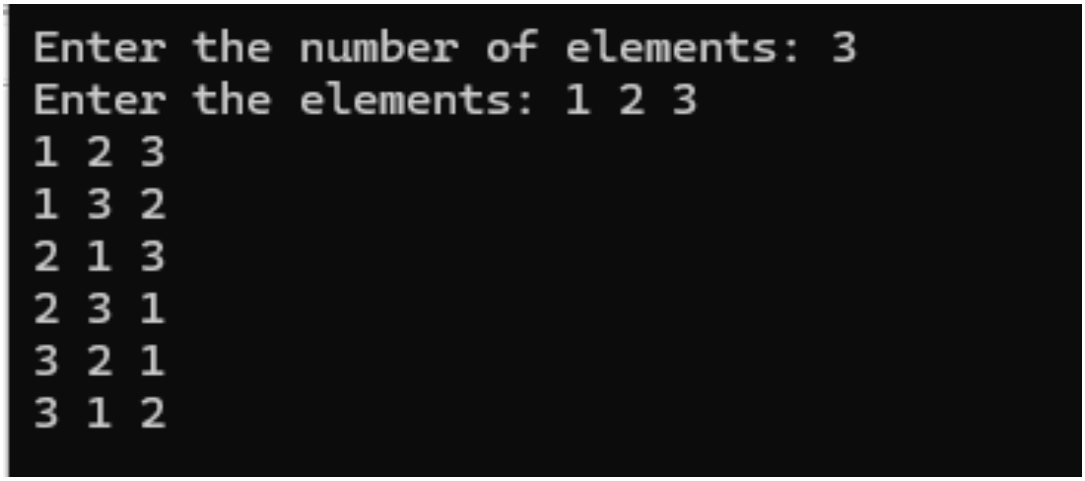




Implement Johnson Trotter algorithm to generate permutations.

```
#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]); }
}
}
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;
}
```

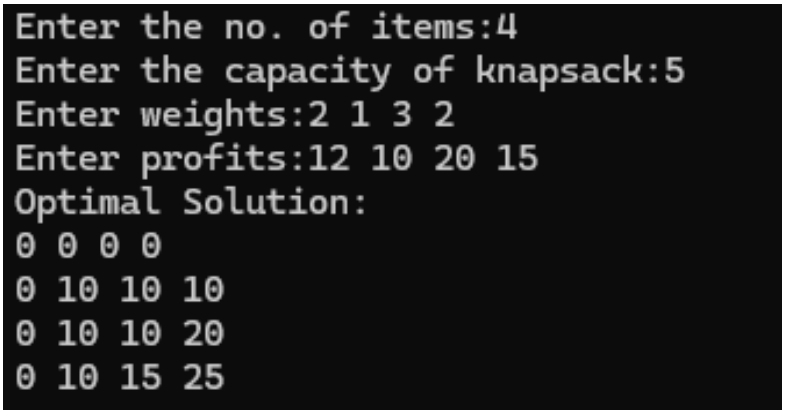
OUTPUT-



Implement 0/1 Knapsack problem using 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]));
}
}
}
}
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

Lab program 7

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 / w[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++) {
        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 38.33.

Process returned 0 (0x0)   execution time : 72.736 s
Press any key to continue.
```

Leetcode

1334. Find the City With the Smallest Number of Neighbors at a Threshold Distance

Medium | Topics | Companies | Hint

There are `n` cities numbered from `0` to `n-1`. Given the array `edges` where `edges[i] = [from_i, to_i, weight_i]` represents a bidirectional and weighted edge between cities `from_i` and `to_i`, and given the integer `distanceThreshold`.

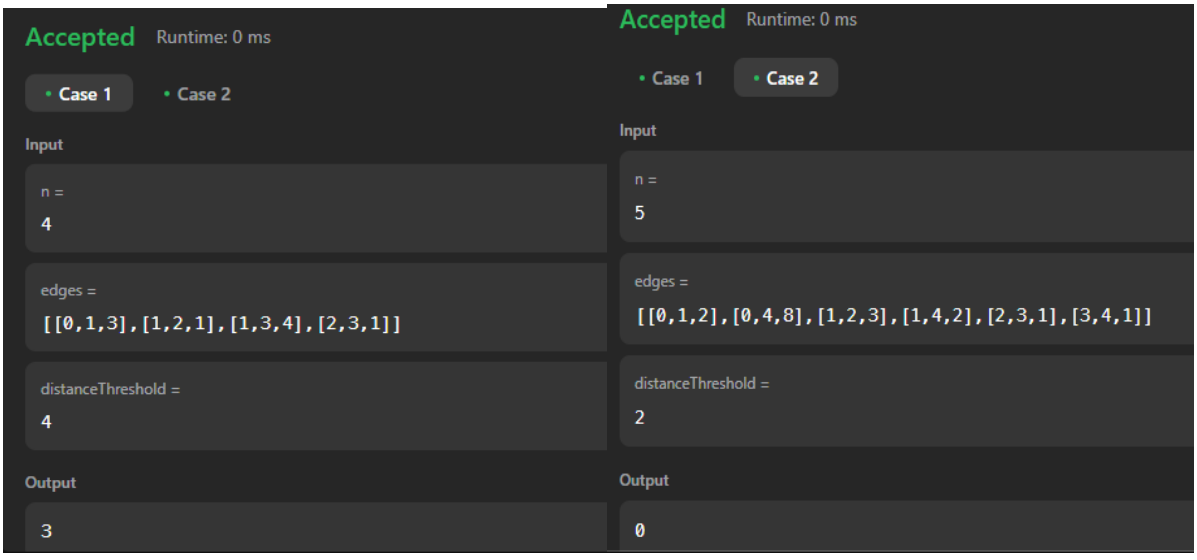
Return the city with the smallest number of cities that are reachable through some path and whose distance is **at most** `distanceThreshold`, If there are multiple such cities, return the city with the greatest number.

Notice that the distance of a path connecting cities ***i*** and ***j*** is equal to the sum of the edges' weights along that path.

```
int findTheCity(int n, int** edges, int edgesSize, int* edgesColSize, int distanceThreshold) {
    short i,j,k,**dist=(short**)malloc(sizeof(short*)*n);

    for(i=0;i<n;i++){
        dist[i]=(short*)malloc(2*n);
        for(j=0;j<n;j++)
```

```
            dist[i][j]=i==j?0:SHRT_MAX;
    }

    for(i=0;i<edgesSize;i++){
        dist[edges[i][0]][edges[i][1]]=edges[i][2];
        dist[edges[i][1]][edges[i][0]]=edges[i][2];
    }

    for(i=0;i<n;i++)
        for(j=0;j<n;j++)
            for(k=0;k<n;k++)
                dist[j][k]=dist[j][k]<dist[j][i]+dist[i][k]?dist[j][k]:dist[j][i]+dist[i][k];

    short *reached=(short*)malloc(2*n);
    for(i=0;i<n;i++){
        reached[i]=0;
        for(j=0;j<n;j++)
            dist[i][j]<=distanceThreshold?reached[i]++:1;
    }
    for(i=0;i<n;free(dist[i++]));
    free(dist);

    short res=n-1,min=reached[n-1];
    for(i=n-1;i>=0;i--)
        if(reached[i]<min){
            min=reached[i];
            res=i;
        }
    free(reached);

    return res;
}
```

OUTPUT –



Lab program 8

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

```
#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
Process returned 0 (0x0)   execution time : 66.658 s
```

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++) {
      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: