VISVESVARAYA TECHNOLOGICAL UNIVERSITY

"JnanaSangama", Belgaum -590014, Karnataka.

LAB REPORT
On

ANALYSIS AND DESIGN OF ALGORITHMS (23CS4PCADA)

Submitted by

Bhavya J Makadia (1BM23CS064)

in partial fulfillment for the award of the degree of
BACHELOR OF ENGINEERING
in
COMPUTER SCIENCE AND ENGINEERING

B.M.S. COLLEGE OF ENGINEERING
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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 **Bhavya J Makadia (1BM23CS064)**, who is a bonafide student of **B. M. S. College of Engineering**. It is in partial fulfillment for the award of **Bachelor of Engineering in Computer Science and Engineering** of the Visvesvaraya Technological University, Belgaum during the 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.

Anusha S
Assistant Professor
Department of CSE
BMSCE, Bengaluru

Dr. Kavitha Sooda
Professor and Head
Department of CSE
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.

GitHub link: https://github.com/BhoomiSuresh/ADA.git

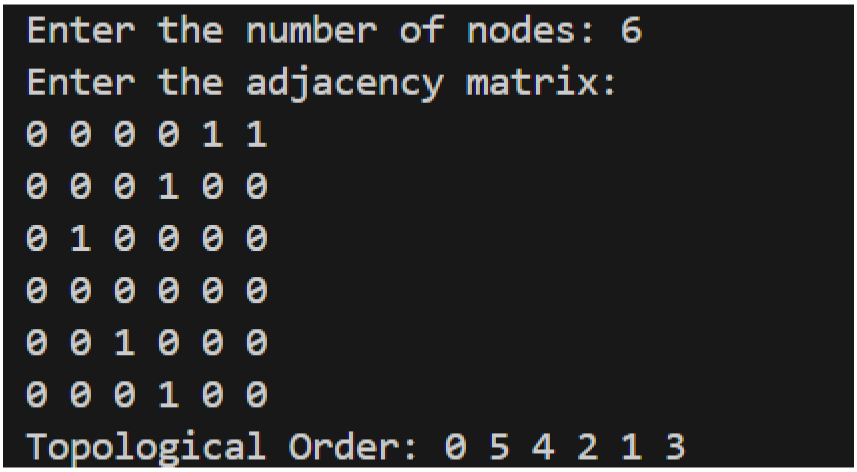
Lab program 1:

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

Code

```
#include <stdio.h>

int n, a[10][10], res[10], visited[10], top = 0;

void dfs(int node) {
    visited[node] = 1;
    for (int i = 0; i < n; i++) {
        if (a[node][i] == 1 && !visited[i]) {
            dfs(i);
        }
    }
    res[top++] = node;
}

void topologicalSort() {
    for (int i = 0; i < n; i++) {
        visited[i] = 0;
    }
    for (int i = 0; i < n; i++) {
        if (!visited[i]) {
            dfs(i);
        }
    }
}
int main() {
    printf("Enter the number of nodes: ");
    scanf("%d", &n);

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

    topologicalSort();

    printf("Topological Order: ");
    for (int i = top - 1; i >= 0; i--) {
        printf("%d ", res[i]);
    }
    printf("\n");

    return 0;
}
```

Screenshot of Output



```
Enter the number of nodes: 6
Enter the adjacency matrix:
0 0 0 0 1 1
0 0 0 1 0 0
0 1 0 0 0 0
0 0 0 0 0 0
0 0 1 0 0 0
0 0 0 1 0 0
Topological Order: 0 5 4 2 1 3
```

LeetCode Program related to Topological sorting

Code

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

    N* adjList[numCourses];

    int visited[numCourses];

    int recStack[numCourses];


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

        visited[i]=0;

        recStack[i]=0;

    }
```

Lab program 2:

Implement Johnson Trotter algorithm to generate permutations.

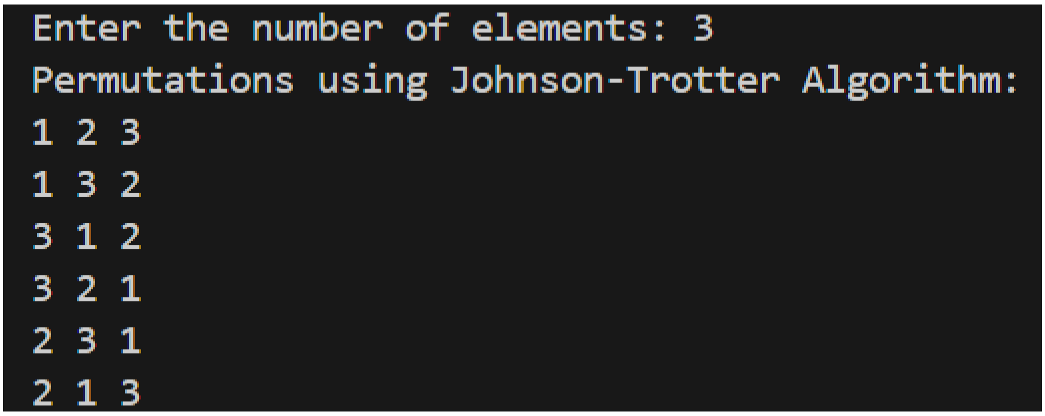
Code

```
#include <stdio.h>

#include <stdlib.h>

#define LEFT -1

#define RIGHT 1


// Function to print a permutation

void printPermutation(int perm[], int n) {

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

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

    }

    printf("\n");

}
```

```
// Function to find the largest mobile element
int getMobile(int perm[], int dir[], int n) {
    int mobile = 0;
    for (int i = 0; i < n; i++) {
        if ((dir[i] == LEFT && i != 0 && perm[i] > perm[i - 1]) ||
            (dir[i] == RIGHT && i != n - 1 && perm[i] > perm[i + 1])) {
            if (perm[i] > mobile) {
                mobile = perm[i];
            }
        }
    }
    return mobile;
}

// Function to get the index of the mobile element
int findIndex(int perm[], int n, int mobile) {
    for (int i = 0; i < n; i++) {
        if (perm[i] == mobile)
            return i;
    }
    return -1;
}

// Main function implementing Johnson-Trotter
void johnsonTrotter(int n) {
    int perm[n];
    int dir[n];
```

```
// Initialize permutation and directions
for (int i = 0; i < n; i++) {
    perm[i] = i + 1;
    dir[i] = LEFT;
}

// Print the first permutation
printPermutation(perm, n);

for (int count = 1; count < 1 << n; count++) {
    int mobile = getMobile(perm, dir, n);
    if (mobile == 0) break;

    int pos = findIndex(perm, n, mobile);
    int swapPos = (dir[pos] == LEFT) ? pos - 1 : pos + 1;

    // Swap the mobile element with the adjacent in its direction
    int temp = perm[pos];
    perm[pos] = perm[swapPos];
    perm[swapPos] = temp;

    int tempDir = dir[pos];
    dir[pos] = dir[swapPos];
    dir[swapPos] = tempDir;

    pos = swapPos;

    // Reverse direction of elements greater than mobile
    for (int i = 0; i < n; i++) {
            if (perm[i] > mobile)
                dir[i] = -dir[i];
        }

        printPermutation(perm, n);
    }
}

int main() {
    int n;
    printf("Enter the number of elements: ");
    scanf("%d", &n);
    printf("Permutations using Johnson-Trotter Algorithm:\n");
    johnsonTrotter(n);
    return 0;
}
```

Screenshot of Output



```
Enter the number of elements: 3
Permutations using Johnson-Trotter Algorithm:
1 2 3
1 3 2
3 1 2
3 2 1
2 3 1
2 1 3
```

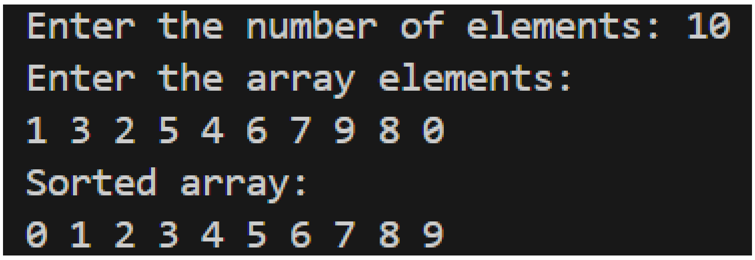
Lab program 3:

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>

void merge_sort(int a[], int low, int high);
void simple_sort(int a[], int low, int mid, int high);

int main() {
    int n, i;
    clock_t start, end;
    double time_taken;

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

    int a[n];  // Variable length array

    printf("Enter the array elements:\n");
    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:\n");
    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[high + 1];  // Temporary array for merging

    while (i <= mid && j <= high) {
        if (a[i] < a[j]) {
            c[k++] = a[i++];
        } else {
            c[k++] = a[j++];
        }
    }

    while (i <= mid) {
        c[k++] = a[i++];
    }

    while (j <= high) {
        c[k++] = a[j++];
    }

    for (i = low; i <= high; i++) {
        a[i] = c[i];
    }
}
```

Screenshot of Output



```
Enter the number of elements: 10
Enter the array elements:
1 3 2 5 4 6 7 9 8 0
Sorted array:
0 1 2 3 4 5 6 7 8 9
```

LeetCode Program related to sorting.

Code

```
def countRangeSum(self, nums, lower, upper):
    first = [0]
    for num in nums:
        first.append(first[-1] + num)
    def sort(lo, hi):
        mid = (lo + hi) / 2
        if mid == lo:
            return 0
        count = sort(lo, mid) + sort(mid, hi)
        i = j = mid
        for left in first[lo:mid]:
            while i < hi and first[i] - left <  lower: i += 1
            while j < hi and first[j] - left <= upper: j += 1
            count += j - i
        first[lo:hi] = sorted(first[lo:hi])
        return count
    return sort(0, len(first))
```

Lab program 4:

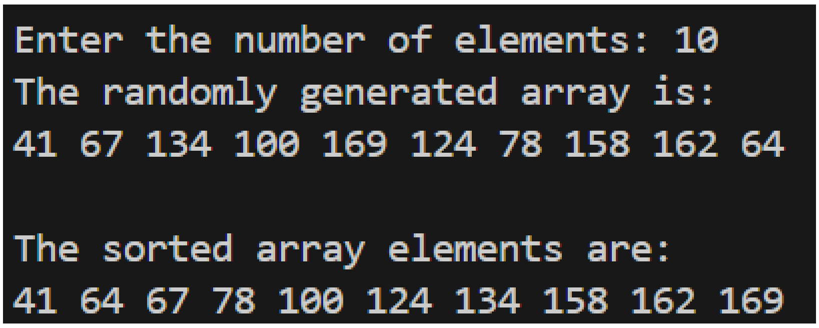
Sort a given set of N integer elements using Quick Sort technique and compute its time taken.

Code

```
#include <stdio.h>

#include <stdlib.h>

#include <time.h>


#define MAX 5000


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

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


int main() {

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

  clock_t start, end;

  double time_taken;


  while (ch) {

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

    scanf("%d", &n);


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

      a[i] = rand() % 200;


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

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

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

    printf("\n");
```

```
        start = clock();
        quicksort(a, 0, n - 1);
        end = clock();

        printf("\nThe sorted array elements are:\n");
        for (i = 0; i < n; i++)
            printf("%d ", a[i]);
        printf("\n");

        time_taken = (double)(end - start) / CLOCKS_PER_SEC;
        printf("Time taken = %f seconds\n", time_taken);

        printf("\nDo you wish to continue? (0 = No, 1 = Yes): ");
        scanf("%d", &ch);
    }

    return 0;
}

void quicksort(int a[], int low, int high) {
    int mid;
    if (low < high) {
        mid = partition(a, low, high);
        quicksort(a, low, mid - 1);
        quicksort(a, mid + 1, high);
    }
}

int partition(int a[], int low, int high) {
    int key = a[low];
    int i = low + 1;
    int j = high;
    int temp;

    while (i <= j) {
        while (i <= high && a[i] <= key)
            i++;
        while (a[j] > key)
            j--;
        if (i < j) {
            temp = a[i];
            a[i] = a[j];
            a[j] = temp;
        } else {
            temp = a[j];
            a[j] = a[low];
            a[low] = temp;
        }
    }
    return j;
}
```

Screenshot of Output



```
Enter the number of elements: 10
The randomly generated array is:
41 67 134 100 169 124 78 158 162 64

The sorted array elements are:
41 64 67 78 100 124 134 158 162 169
```

LeetCode Program related to sorting.

Code

```
class Solution:
    def findKthLargest(self, nums: List[int], k: int) -> int:
        maxHeap = nums
        for i in range(len(maxHeap)):
            maxHeap[i] = -maxHeap[i]
        heapify(maxHeap)
        for i in range(k-1):
            heappop(maxHeap)
        return -maxHeap[0]
```

Lab program 5:

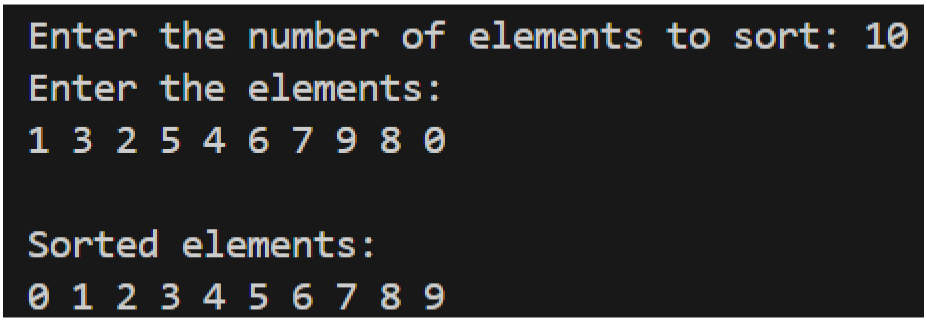
Sort a given set of N integer elements using Heap Sort technique and compute its time taken.

Code

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

// Heapify subtree rooted at index i in array a[], size n
void heapify(int a[], int n, int i) {
    int largest = i;        // Initialize largest as root
    int left = 2 * i + 1;   // left child index
    int right = 2 * i + 2;  // right child index

    if (left < n && a[left] > a[largest])
        largest = left;
    if (right < n && a[right] > a[largest])
        largest = right;

    if (largest != i) {
        int temp = a[i];
        a[i] = a[largest];
        a[largest] = temp;

        heapify(a, n, largest); // Recursively heapify affected subtree
    }
}

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

    // Extract elements one by one from heap
    for (int i = n - 1; i > 0; i--) {
        // Move current root to end
        int temp = a[0];
        a[0] = a[i];
        a[i] = temp;

        // call max heapify on the reduced heap
        heapify(a, i, 0);
    }
}
```

```
int main() {
    int n, choice = 1;

    while (choice) {
        printf("\nEnter the number of elements to sort: ");
        scanf("%d", &n);
        int a[n];

        printf("Enter the elements:\n");
        for (int i = 0; i < n; i++)
            scanf("%d", &a[i]);

        clock_t start = clock();
        heapsort(a, n);
        clock_t end = clock();

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

        double time_taken = ((double)(end - start)) / CLOCKS_PER_SEC;
        printf("Time taken: %lf seconds\n", time_taken);

        printf("Do you wish to run again? (1/0): ");
        scanf("%d", &choice);
    }

    return 0;
}
```

Screenshot of Output



```
Enter the number of elements to sort: 10
Enter the elements:
1 3 2 5 4 6 7 9 8 0

Sorted elements:
0 1 2 3 4 5 6 7 8 9
```

Lab program 6:

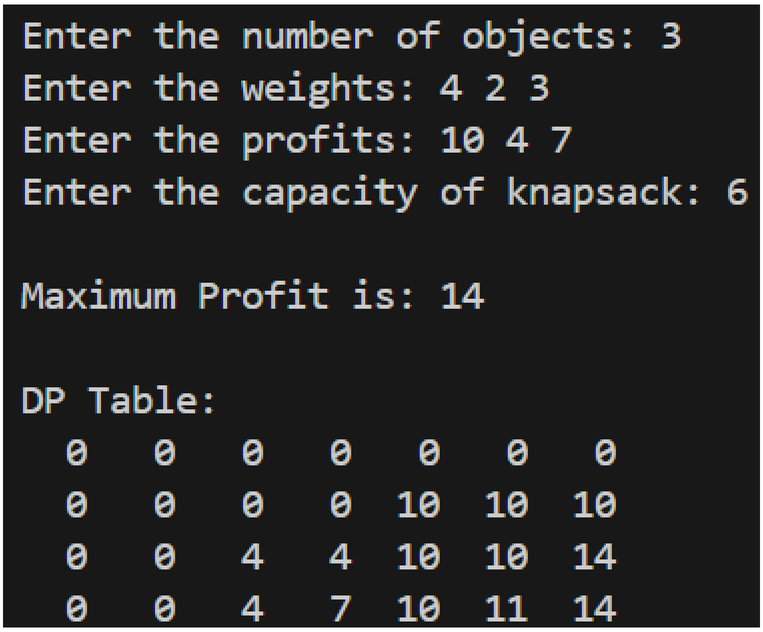
Implement 0/1 Knapsack problem using dynamic programming.

Code

```
#include <stdio.h>


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


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


void knapsack(int n, int w[10], int p[10], int c) {
   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("\nMaximum Profit is: %d\n", v[n][c]);
    // Optional: Print the DP table
    printf("\nDP Table:\n");
    for (i = 0; i <= n; i++) {
        for (j = 0; j <= c; j++) {
            printf("%3d ", v[i][j]);
        }
        printf("\n");
    }
}

int main() {
    printf("Entear the number of objects: ");
    scanf("%d", &n);

    printf("Enter the weights: ");
    for (i = 1; i <= n; i++) {
        scanf("%d", &w[i]);
    }

    printf("Enter the profits: ");
    for (i = 1; i <= n; i++) {
        scanf("%d", &p[i]);
    }

    printf("Enter the capacity of knapsack: ");
    scanf("%d", &c);

    knapsack(n, w, p, c);
    return 0;
}
```

Screenshot of Output



```
Enter the number of objects: 3
Enter the weights: 4 2 3
Enter the profits: 10 4 7
Enter the capacity of knapsack: 6

Maximum Profit is: 14

DP Table:
   0   0   0   0   0   0   0
   0   0   0   0  10  10  10
   0   0   4   4  10  10  14
   0   0   4   7  10  11  14
```

LeetCode Program related to Knapsack problem or Dynamic Programming.

Code

```
class Solution:
    def maxSizeSlices(self, slices: List[int]) -> int:
        n = len(slices) // 3
        def linear(arr):
            eat = [[0] + [-math.inf]*n] * 2
            for x in arr:
                eat.append([i and max(eat[-1][i], eat[-2][i-1]+x) for i in range(n+1)])
            return max(l[n] for l in eat)
        return max(linear(slices[1:]), linear(slices[:-1]))
```

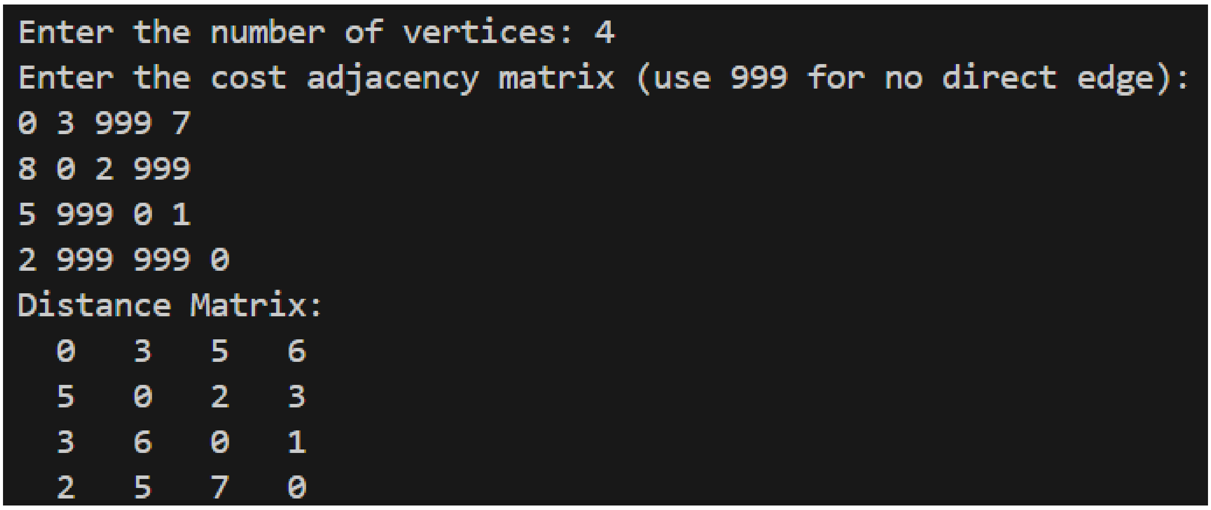
Lab program 7:

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

Code

```
#include <stdio.h>


#define INF 999  // Representation of infinity


int a[10][10], D[10][10], n;


void floyd(int [][10], int);

int min(int, int);


int main() {

    int i, j;


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

    scanf("%d", &n);


    printf("Enter the cost adjacency matrix (use 999 for no direct edge):\n");

    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++) {
            if (D[i][j] == INF)
                printf("INF ");
            else
                printf("%3d ", D[i][j]);
        }
        printf("\n");
    }
    return 0;
}

void floyd(int a[][10], int n) {
    int i, j, k;
    // Initialize the distance matrix with input adjacency matrix
    for (i = 0; i < n; i++) {
        for (j = 0; j < n; j++) {
            D[i][j] = a[i][j];
        }
    }
    // Floyd–Warshall algorithm
    for (k = 0; k < n; k++) {
        for (i = 0; i < n; i++) {
            for (j = 0; j < n; j++) {
                if (D[i][k] + D[k][j] < D[i][j]) {
                    D[i][j] = D[i][k] + D[k][j];
                }
            }
        }
    }
}
int min(int a, int b) {
    return (a < b) ? a : b;
}
```

Screenshot of Output



```
Enter the number of vertices: 4
Enter the cost adjacency matrix (use 999 for no direct edge):
0 3 999 7
8 0 2 999
5 999 0 1
2 999 999 0
Distance Matrix:
  0   3   5   6
  5   0   2   3
  3   6   0   1
  2   5   7   0
```

LeetCode Program related to shortest distance calculation.

Code

```
import heapq
from collections import defaultdict
import sys

def countPaths(n, roads):
    mod = 10**9 + 7
    adj = defaultdict(list)
    for u, v, t in roads:
        adj[u].append((v, t))
        adj[v].append((u, t))

    shortesttime = [sys.maxsize] * n
    cnt = [0] * n
    pq = [(0, 0)]  # (time, node)

    shortesttime[0] = 0
    cnt[0] = 1

    while pq:
        time, node = heapq.heappop(pq)

        if time > shortesttime[node]:
            continue

        for nbr, rtime in adj[node]:
            if time + rtime < shortesttime[nbr]:
                shortesttime[nbr] = time + rtime
                cnt[nbr] = cnt[node]
                heapq.heappush(pq, (shortesttime[nbr], nbr))
            elif time + rtime == shortesttime[nbr]:
                cnt[nbr] = (cnt[nbr] + cnt[node]) % mod

    return cnt[-1]
```

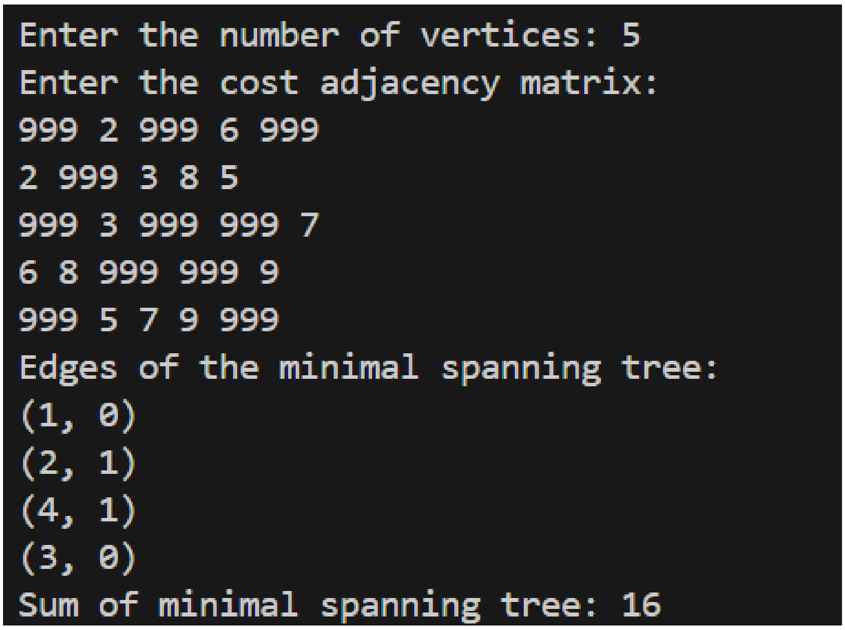
Lab program 8:

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

Code

```
#include <stdio.h>
#define INF 999  // Representation of infinity
int cost[10][10], t[10][2], sum;
int n;
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)\n", t[i][0], t[i][1]);
    }

    printf("Sum of minimal spanning tree: %d\n", sum);
    return 0;
}

void prims(int cost[10][10], int n) {
    int i, j, u, v, k = 0;
    int min, source = 0;
    int p[10], d[10], s[10];

    // Initialize
    for (i = 0; i < n; i++) {
        d[i] = cost[source][i];
        s[i] = 0;
        p[i] = source;
    }
    s[source] = 1;
    sum = 0;

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

        // Find the vertex with minimum edge cost to MST
        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;

            // 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;
                }
            }
        }
    }}
```

Screenshot of Output



```
Enter the number of vertices: 5
Enter the cost adjacency matrix:
999 2 999 6 999
2 999 3 8 5
999 3 999 999 7
6 8 999 999 9
999 5 7 9 999
Edges of the minimal spanning tree:
(1, 0)
(2, 1)
(4, 1)
(3, 0)
Sum of minimal spanning tree: 16
```

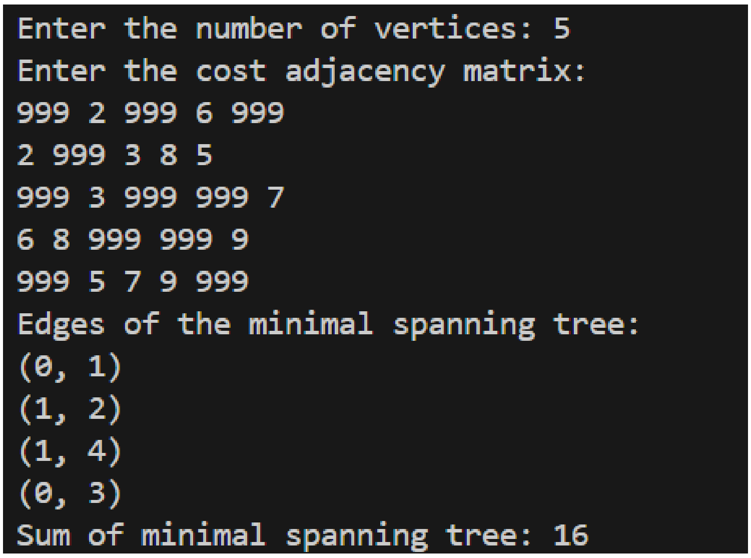
Find Minimum Cost Spanning Tree of a given undirected graph using Kruskal's algorithm.

Code

```
#include <stdio.h>
#define INF 999
int cost[10][10], t[10][2], sum;
int n;
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)\n", t[i][0], t[i][1]);
  }
  printf("Sum of minimal spanning tree: %d\n", sum);
  return 0;
}
```

```
void kruskal(int cost[10][10], int n) {
    int parent[10];
    int u, v, i, j, k = 0, count = 0;
    int min;

    sum = 0;

    // Initialize the parent array
    for (i = 0; i < n; i++) {
        parent[i] = i;
    }

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

        // Find the minimum edge (u, v) such that u and v are in different sets
        for (i = 0; i < n; i++) {
            for (j = 0; j < n; j++) {
                if (find(parent, i) != find(parent, j) && cost[i][j] < min) {
                    min = cost[i][j];
                    u = i;
                    v = j;
                }
            }
        }
        if (u != -1 && v != -1) {
            int root_u = find(parent, u);
            int root_v = find(parent, v);

            // Union the sets
            parent[root_u] = root_v;

            t[k][0] = u;
            t[k][1] = v;
            k++;
            sum += min;
            count++;
        }}}
int find(int parent[10], int i) {
    while (parent[i] != i) {
        i = parent[i];
    }
    return i;
}
```

Screenshot of Output



```
Enter the number of vertices: 5
Enter the cost adjacency matrix:
999 2 999 6 999
2 999 3 8 5
999 3 999 999 7
6 8 999 999 9
999 5 7 9 999
Edges of the minimal spanning tree:
(0, 1)
(1, 2)
(1, 4)
(0, 3)
Sum of minimal spanning tree: 16
```

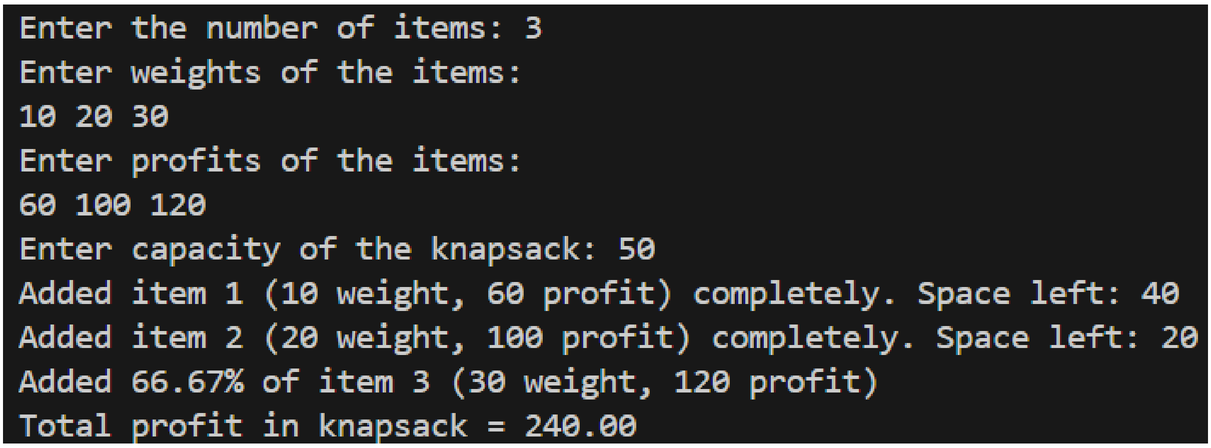
Lab program 9:

Implement Fractional Knapsack using Greedy technique.

Code

```
#include <stdio.h>

int main() {
    int n, i;
    printf("Enter the number of items: ");
    scanf("%d", &n);

    int weights[n], profits[n];
    float ratio[n];
    int used[n];

    printf("Enter weights of the items:\n");
    for (i = 0; i < n; i++) {
        scanf("%d", &weights[i]);
    }

    printf("Enter profits of the items:\n");
    for (i = 0; i < n; i++) {
        scanf("%d", &profits[i]);
    }

    int capacity;
    printf("Enter capacity of the knapsack: ");
    scanf("%d", &capacity);

    // Initialize used array to 0
    for (i = 0; i < n; i++) {
        used[i] = 0;
        ratio[i] = (float)profits[i] / weights[i];  // profit/weight ratio
    }

    int current_weight = capacity;
    float total_value = 0.0;

    while (current_weight > 0) {
        int maxi = -1;
        for (i = 0; i < n; i++) {
            if (!used[i]) {
                if (maxi == -1 || ratio[i] > ratio[maxi]) {
                    maxi = i;
                }
            }
        }
        if (maxi == -1) break;  // No items left
        used[maxi] = 1;

        if (weights[maxi] <= current_weight) {
            // Take whole item
            current_weight -= weights[maxi];
            total_value += profits[maxi];
            printf("Added item %d (%d weight, %d profit) completely. Space left: %d\n",
                   maxi + 1, weights[maxi], profits[maxi], current_weight);
        } else {
            // Take fraction of item
            float fraction = (float)current_weight / weights[maxi];
            total_value += profits[maxi] * fraction;
            printf("Added %.2f%% of item %d (%d weight, %d profit)\n",
                   fraction * 100, maxi + 1, weights[maxi], profits[maxi]);
            current_weight = 0;
        }
    }

    printf("Total profit in knapsack = %.2f\n", total_value);

    return 0;
}
```

Screenshot of Output



```
Enter the number of items: 3
Enter weights of the items:
10 20 30
Enter profits of the items:
60 100 120
Enter capacity of the knapsack: 50
Added item 1 (10 weight, 60 profit) completely. Space left: 40
Added item 2 (20 weight, 100 profit) completely. Space left: 20
Added 66.67% of item 3 (30 weight, 120 profit)
Total profit in knapsack = 240.00
```

LeetCode Program related to Greedy Technique algorithms.

Code

```
def maximumUnits(self, boxTypes: List[List[int]], truckSize: int) -> int:
        boxTypes.sort(key=lambda a:-a[1])
        max_units = 0
        for box in boxTypes:
                if truckSize < 0 : break
                max_units += min(truckSize, box[0]) * box[1]
                truckSize -= box[0]
        return max_units
```

Lab program 10:

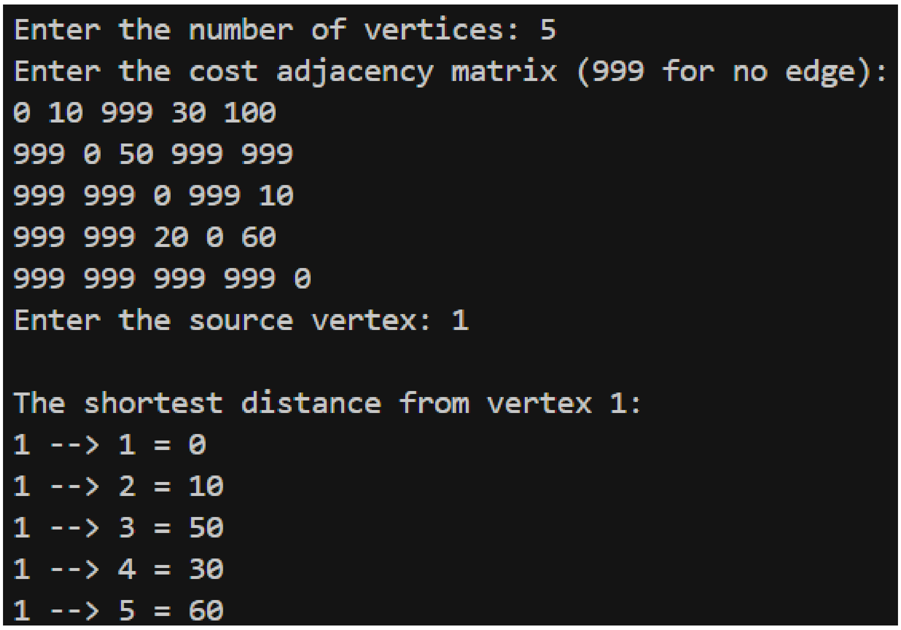
From a given vertex in a weighted connected graph, find shortest paths to other vertices using Dijkstra's algorithm.

Code

```
#include <stdio.h>


#define MAX 20
#define INF 999


int main() {
   int i, j, n, v, k, min, u;
   int c[MAX][MAX], s[MAX], d[MAX];


   printf("Enter the number of vertices: ");
   scanf("%d", &n);
   printf("Enter the cost adjacency matrix (999 for no edge):\n");
```

```
for (i = 1; i <= n; i++) {
        for (j = 1; j <= n; j++) {
            scanf("%d", &c[i][j]);
        }
    }

    printf("Enter the source vertex: ");
    scanf("%d", &v);

    // Initialization
    for (i = 1; i <= n; i++) {
        s[i] = 0;             // Not visited
        d[i] = c[v][i];       // Initial distances from source
    }

    d[v] = 0;  // Distance to itself is 0
    s[v] = 1;  // Mark source as visited

    for (k = 2; k <= n; k++) {
        min = INF;
        u = -1;

        // Find the vertex with minimum distance
        for (i = 1; i <= n; i++) {
            if (s[i] == 0 && d[i] < min) {
                min = d[i];
                u = i;
            }
        }
        if (u == -1) break; // No reachable vertex

        s[u] = 1;

        // Update distances
        for (i = 1; i <= n; i++) {
            if (s[i] == 0 && d[i] > d[u] + c[u][i]) {
                d[i] = d[u] + c[u][i];
            }
        }
    }

    // Print result
    printf("\nThe shortest distance from vertex %d:\n", v);
    for (i = 1; i <= n; i++) {
        if (d[i] != INF)
            printf("%d --> %d = %d\n", v, i, d[i]);
        else
            printf("%d --> %d = Unreachable\n", v, i);
    }

    return 0;
}
```

Screenshot of Output



```
Enter the number of vertices: 5
Enter the cost adjacency matrix (999 for no edge):
0 10 999 30 100
999 0 50 999 999
999 999 0 999 10
999 999 20 0 60
999 999 999 999 0
Enter the source vertex: 1

The shortest distance from vertex 1:
1 --> 1 = 0
1 --> 2 = 10
1 --> 3 = 50
1 --> 4 = 30
1 --> 5 = 60
```

Lab program 11:

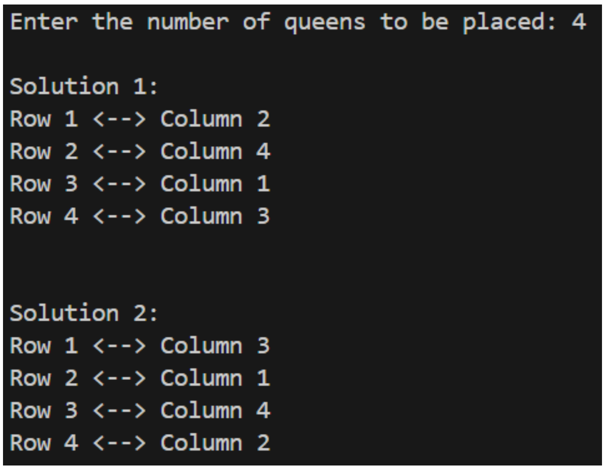
Implement "N-Queens Problem" using Backtracking.

Code

```
#include <stdio.h>

#include <math.h>


int x[20], count = 1;


int place(int k, int j) {

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

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

            return 0; // Not safe to place queen

    }

    return 1; // Safe

}
```

```
void queens(int k, int n) {
    for (int j = 1; j <= n; j++) {
        if (place(k, j)) {
            x[k] = j;
            if (k == n) {
                printf("\nSolution %d:\n", count++);
                for (int i = 1; i <= n; i++)
                    printf("Row %d <--> Column %d\n", i, x[i]);
                printf("\n");
            } else {
                queens(k + 1, n);
      }}}}
int main() {
    int n;
    printf("Enter the number of queens to be placed: ");
    scanf("%d", &n);
    queens(1, n);
    return 0;
}
```

Screenshot of Output



```
Enter the number of queens to be placed: 4

Solution 1:
Row 1 <--> Column 2
Row 2 <--> Column 4
Row 3 <--> Column 1
Row 4 <--> Column 3


Solution 2:
Row 1 <--> Column 3
Row 2 <--> Column 1
Row 3 <--> Column 4
Row 4 <--> Column 2
```