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LAB REPORT
On

ANALYSIS AND DESIGN OF ALGORITHMS (23CS4PCADA)

Submitted by

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in partial fulfillment for the award of the degree of
BACHELOR OF ENGINEERING
in
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 **K VEENA(1BM23CS135)** 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.

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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 1.1:

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

Program full details

Code

```
#include <stdio.h>
#include <stdbool.h>
#define MAX 100

int graph[MAX][MAX];
bool visited[MAX];
int stack[MAX];
int top = -1;
int n;

void push(int v) {
   stack[++top] = v;
}


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


   push(node);
```

```
}


void topologicalSort() {

    for (int i = 0; i < n; i++) {
        visited[i] = false;
    }

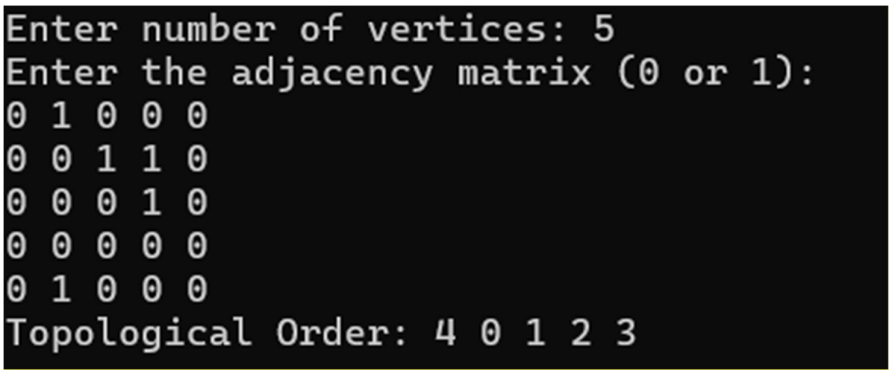
    for (int i = 0; i < n; i++) {
        if (!visited[i]) {
            dfs(i);
        }
    }
    printf("Topological Order: ");
    while (top != -1) {
        printf("%d ", stack[top--]);
    }
    printf("\n");
}

int main() {

    printf("Enter number of vertices: ");
    scanf("%d", &n);
    printf("Enter the adjacency matrix (0 or 1):\n");
    for (int i = 0; i < n; i++) {
        for (int j = 0; j < n; j++) {
            scanf("%d", &graph[i][j]);
```

```
        }
    }
    topologicalSort();
    return 0;
}
```

Screenshot of Output



Lab program 1.2:

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++) {
        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;

            }

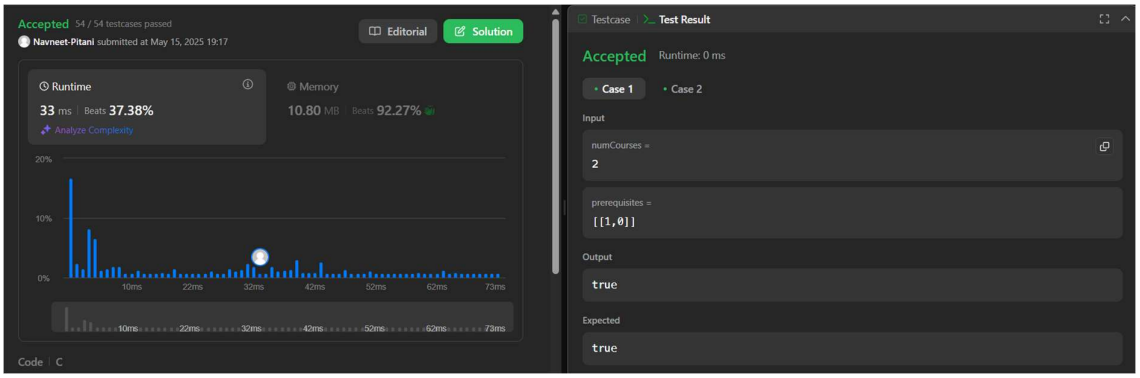
        }

    }

    return true;

}
```

Screenshot of Output



Lab program 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.

Code

```
#include <stdio.h>

#include <stdlib.h>

#include <time.h>


void merge(int arr[], int left, int right, int mid) {

    int i, j, k;

    int n1 = mid - left + 1;

    int n2 = right - mid;

    int L[n1], R[n2];


    for(i = 0; i < n1; i++) {

        L[i] = arr[left + i];

    }

    for(j = 0; j < n2; j++) {

        R[j] = arr[mid + 1 + j];

    }


    i = 0;
```

```
   j = 0;
   k = left;

   while(i < n1 && j < n2) {
      if(L[i] <= R[j]) {
         arr[k] = L[i];
         i++;
      } else {
         arr[k] = R[j];
         j++;
      }
      k++;
   }

   while(i < n1) {
      arr[k] = L[i];
      i++;
      k++;
   }

   while(j < n2) {
      arr[k] = R[j];
      j++;
      k++;
   }
}

void mergeSort(int arr[], int left, int right) {
   if(left < right) {
```

```
        int mid = left + (right - left) / 2;

        mergeSort(arr, left, mid);
        mergeSort(arr, mid + 1, right);
        merge(arr, left, right, mid);
    }
}

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

int main() {
    int n;
    clock_t start, end;



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

    int arr[n];

    srand(time(NULL));


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

```
        arr[i] = rand() % 1000;
    }


    printf("Original Array: ");
    print(arr, n);

    start = clock();


    mergeSort(arr, 0, n - 1);


    end = clock();

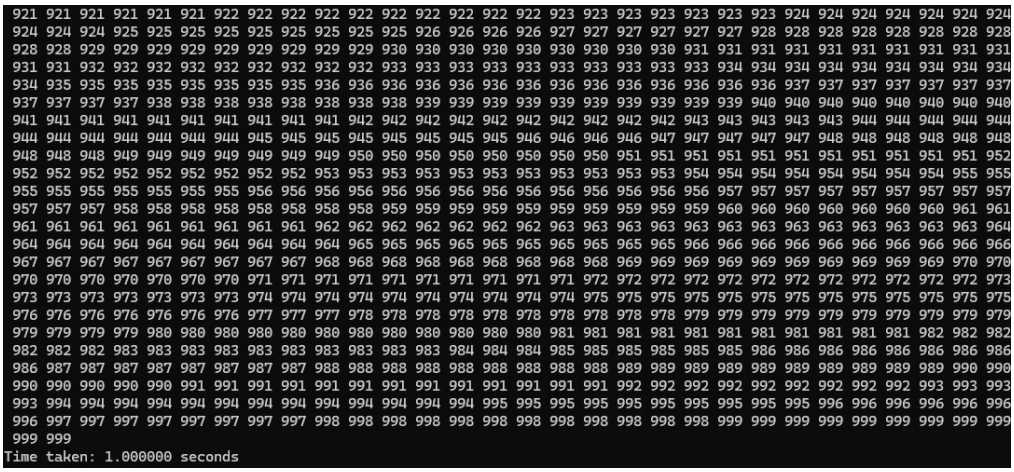

    printf("Sorted Array: ");
    print(arr, n);

    printf("Time taken: %f seconds\n",1000* (double)(end - start) / CLOCKS_PER_SEC);




    return 0;
}
```

Screenshot of Output



Lab program 3:

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>



int partition(int arr[], int low, int high) {
    int pivot = arr[high];
    int i = low - 1;



    for (int j = low; j <= high - 1; j++) {
        if (arr[j] < pivot) {
            i++;


            int temp = arr[i];
            arr[i] = arr[j];
            arr[j] = temp;
        }
```

```
    }

    int temp = arr[i + 1];
    arr[i + 1] = arr[high];
    arr[high] = temp;

    return (i + 1);
}

void quickSort(int arr[], int low, int high) {
    if (low < high) {

        int pi = partition(arr, low, high);

        quickSort(arr, low, pi - 1);
        quickSort(arr, pi + 1, high);
    }
}

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

```
int main() {
    int n;
    clock_t start, end;

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

    int arr[n];

    srand(time(NULL));

    for (int i = 0; i < n; i++) {
        arr[i] = rand() % 1001;
    }

    printf("Original Array: ");
    print(arr, n);

    start = clock();

    quickSort(arr, 0, n - 1);
```

```
    end = clock();



    printf("Sorted Array: ");
    print(arr, n);



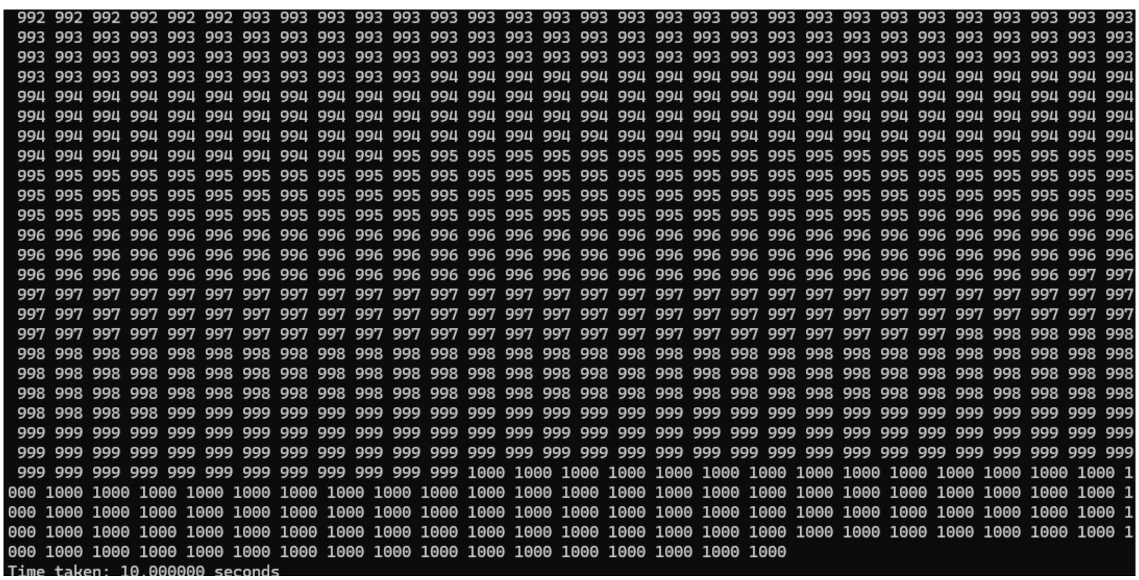
    printf("Time taken: %f seconds\n",1000* (double)(end - start) / CLOCKS_PER_SEC);





    return 0;
}
```

Screenshot of Output



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Time taken: 10.000000 seconds
```

Lab program 4:

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

Code

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

```
#include<conio.h>

int cost[10][10],vt[10],et[10][10],vis[10],j,n;
int sum=0;
int x=1;
int e=0;
void prims();

void main()
{
  int i;

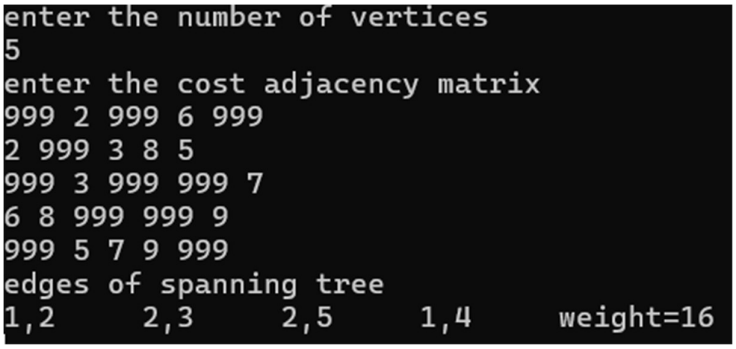
  printf("enter the number of vertices\n");
  scanf("%d",&n);
  printf("enter the cost adjacency matrix\n");
  for(i=1;i<=n;i++)
  {
     for(j=1;j<=n;j++)
     {
          scanf("%d",&cost[i][j]);
     }
     vis[i]=0;
  }
  prims();
  printf("edges of spanning tree\n");
  for(i=1;i<=e;i++)
  {
       printf("%d,%d\t",et[i][0],et[i][1]);
  }
```

```
    printf("weight=%d\n",sum);
    getch();
}

void prims()
{
   int s,min,m,k,u,v;
   vt[x]=1;
   vis[x]=1;
   for(s=1;s<n;s++)
   {
      j=x;
      min=999;
      while(j>0)
      {
            k=vt[j];
            for(m=2;m<=n;m++)
            {
              if(vis[m]==0)
              {
                    if(cost[k][m]<min)
                    {
                      min=cost[k][m];
                      u=k;
                      v=m;
                    }
               }
           }
           j--;
```

```
    }
    vt[++x]=v;
    et[s][0]=u;
    et[s][1]=v;
    e++;
    vis[v]=1;
    sum=sum+min;
  }
}
```

Screenshot of Output



Lab program 5:

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

Code

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

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

```
}

void union1(int i,int j,int parent[10])
{
   if(i<j)
      parent[j]=i;
   else
      parent[i]=j;
}

void kruskal(int n,int a[10][10])
{
   int count,k,min,sum,i,j,t[10][10],u,v,parent[10];
   count=0;
   k=0;
   sum=0;
   for(i=0;i<n;i++)
      parent[i]=i;
   while(count!=n-1)
   {
      min=999;
      for(i=0;i<n;i++)
      {
       for(j=0;j<n;j++)
       {

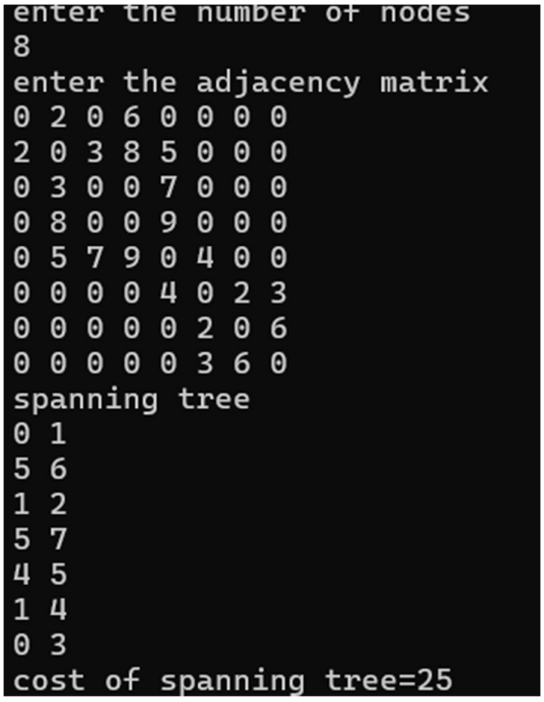
          if(a[i][j]<min && a[i][j]!=0)
          {
            min=a[i][j];
            u=i;
            v=j;                                                    .
           }
```

```
        }
       }
       i=find(u,parent);
       j=find(v,parent);
       if(i!=j)
       {
        union1(i,j,parent);
        t[k][0]=u;
        t[k][1]=v;
        k++;
        count++;
        sum=sum+a[u][v];
       }
       a[u][v]=a[v][u]=999;
    }
    if(count==n-1)
    {
       printf("spanning tree\n");
       for(i=0;i<n-1;i++)
       {
        printf("%d %d\n",t[i][0],t[i][1]);
       }
       printf("cost of spanning tree=%d\n",sum);
    }
    else
       printf("spanning tree does not exist\n");
  }


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

```
    clrscr();
    printf("enter the number of nodes\n");
    scanf("%d",&n);
    printf("enter the adjacency matrix\n");
    for(i=0;i<n;i++)
      for(j=0;j<n;j++)
       scanf("%d",&a[i][j]);
    kruskal(n,a);
    getch();
}
```

Screenshot of Output



Lab program 6:

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

Code

#include <stdio.h>

```
#define INF 999

void dijkstra(int n, int cost[10][10], int src) {
    int i, j, u, dis[10], vis[10], min;

    // Initialize distances and visited flags
    for (i = 1; i <= n; i++) {
        dis[i] = cost[src][i];
        vis[i] = 0;
    }

    vis[src] = 1;

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

        // Find the unvisited vertex with the smallest distance
        for (j = 1; j <= n; j++) {
            if (vis[j] == 0 && dis[j] < min) {
                min = dis[j];
                u = j;
            }
        }

        if (u == -1) break; // All reachable vertices visited

        vis[u] = 1;
```

```
        // Update distances to neighboring vertices
        for (j = 1; j <= n; j++) {
            if (vis[j] == 0 && dis[u] + cost[u][j] < dis[j]) {
                dis[j] = dis[u] + cost[u][j];
            }
        }
    }

    printf("Shortest paths from vertex %d:\n", src);
    for (i = 1; i <= n; i++) {
        if (dis[i] == INF)
            printf("%d -> %d = INF\n", src, i);
        else
            printf("%d -> %d = %d\n", src, i, dis[i]);
    }
}

int main() {
    int src, j, cost[10][10], n, i;

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

    printf("Enter the cost adjacency matrix (use 999 for no connection):\n");
    for (i = 1; i <= n; i++) {
        for (j = 1; j <= n; j++) {
            scanf("%d", &cost[i][j]);
        }
```

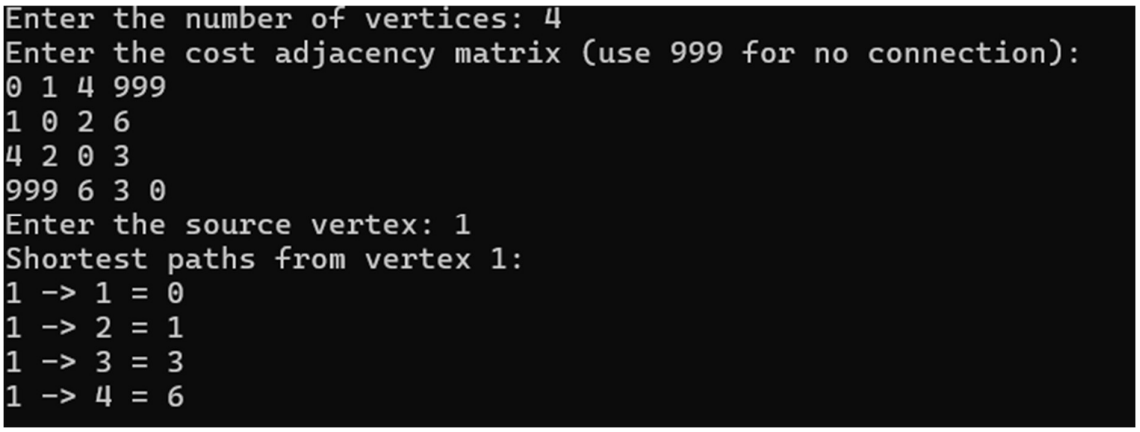
```
    }

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

    dijkstra(n, cost, src);

    return 0;
}
```

Screenshot of Output



Lab program 7:

Implement Johnson Trotter algorithm to generate permutations.

Code

```
#include <stdio.h>

#define LEFT_TO_RIGHT 1
#define RIGHT_TO_LEFT 0
```

```
int searchArr(int a[], int n, int mobile) {
    for (int i = 0; i < n; i++)
        if (a[i] == mobile)
            return i + 1;
    return -1;
}

int getMobile(int a[], int dir[], int n) {
    int mobile_prev = 0, mobile = 0;

    for (int i = 0; i < n; i++) {
        if (dir[a[i] - 1] == RIGHT_TO_LEFT && i != 0) {
            if (a[i] > a[i - 1] && a[i] > mobile_prev) {
                mobile = a[i];
                mobile_prev = mobile;
            }
        }
        if (dir[a[i] - 1] == LEFT_TO_RIGHT && i != n - 1) {
            if (a[i] > a[i + 1] && a[i] > mobile_prev) {
                mobile = a[i];
                mobile_prev = mobile;
            }
        }
    }

    return mobile;
}

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

```
    int mobile = getMobile(a, dir, n);
    int pos = searchArr(a, n, mobile);

    if (mobile == 0) return;

    if (dir[a[pos - 1] - 1] == RIGHT_TO_LEFT) {
        int temp = a[pos - 1];
        a[pos - 1] = a[pos - 2];
        a[pos - 2] = temp;
    } else if (dir[a[pos - 1] - 1] == LEFT_TO_RIGHT) {
        int temp = a[pos];
        a[pos] = a[pos - 1];
        a[pos - 1] = temp;
    }

    for (int i = 0; i < n; i++) {
        if (a[i] > mobile) {
            dir[a[i] - 1] = !dir[a[i] - 1]; // toggle direction
        }
    }

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

int fact(int n) {
    int res = 1;
    for (int i = 1; i <= n; i++)
```

```
        res = res * i;
    return res;
}

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

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

    for (int i = 0; i < n; i++)
        dir[i] = RIGHT_TO_LEFT;

    for (int i = 1; i < fact(n); i++)
        printOnePerm(a, dir, n);
}

int main() {
    int n = 4;
    printPermutation(n);
    return 0;
}
```

Screenshot of Output

```
1234
1243 1423 4123 4132 1432 1342 1324 3124 3142 3412 4312 4321 3421 3241 3214 2314 2341 2431 4231 4213 2413 2143 2134
```

Lab program 8.1:

Implement Fractional Knapsack using Greedy technique.

Code

```
#include <stdio.h>

int main() {
    float weight[50], profit[50], ratio[50];
    float Totalvalue = 0.0, temp, capacity, amount;
    int n, i, j;

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

    for (i = 0; i < n; i++) {
        printf("Enter Weight and Profit for item[%d]:\n", i);
        scanf("%f %f", &weight[i], &profit[i]);
    }

    printf("Enter the capacity of knapsack:\n");
    scanf("%f", &capacity);

    // Calculate profit/weight ratio
    for (i = 0; i < n; i++)
        ratio[i] = profit[i] / weight[i];

    // Sort items by descending ratio
    for (i = 0; i < n; i++) {
        for (j = i + 1; j < n; j++) {
            if (ratio[i] < ratio[j]) {
```

```
            // Swap ratio
            temp = ratio[i];
            ratio[i] = ratio[j];
            ratio[j] = temp;

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

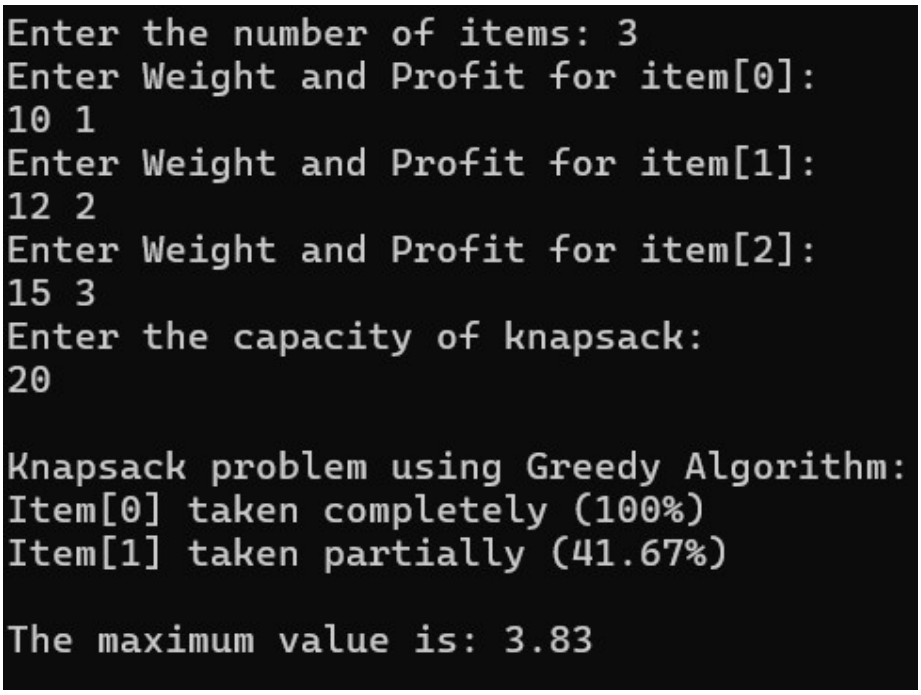
            // Swap profit
            temp = profit[i];
            profit[i] = profit[j];
            profit[j] = temp;
        }
    }
}

printf("\nKnapsack problem using Greedy Algorithm:\n");
for (i = 0; i < n; i++) {
    if (weight[i] <= capacity) {
        // Take full item
        printf("Item[%d] taken completely (100%%)\n", i);
        Totalvalue += profit[i];
        capacity -= weight[i];
    } else {
        // Take fraction of item
        float fraction = capacity / weight[i];
        Totalvalue += profit[i] * fraction;
```

```
            printf("Item[%d] taken partially (%.2f%%)\n", i, fraction * 100);
            break; // Knapsack is now full
        }
    }

    printf("\nThe maximum value is: %.2f\n", Totalvalue);
    return 0;
}
```

Screenshot of Output



Lab program 8.2:

LeetCode Program related to Greedy Technique algorithms

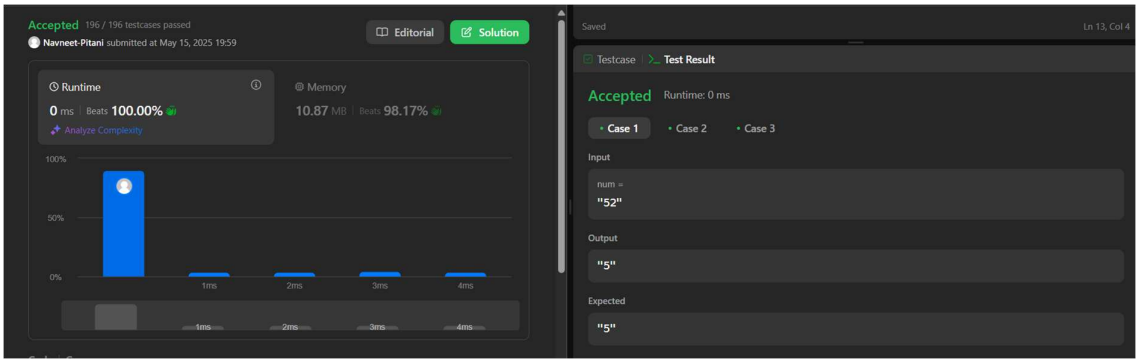
Code

```
char* largestOddNumber(char* num) {
  int len = strlen(num);
```

```
    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
}
```

Screenshot of Output



Lab program 9.1:

Implement 0/1 Knapsack problem using dynamic programming.

Code

```
#include <stdio.h>

// Function to return the maximum of two numbers
int max(int a, int b) {
    return (a > b) ? a : b;
}

// Function to solve the 0/1 Knapsack problem
```

```
int knapsack(int weight[], int profit[], int n, int capacity) {
    int i, w;
    int K[n + 1][capacity + 1];

    // Build the DP table K[][] bottom up
    for (i = 0; i <= n; i++) {
        for (w = 0; w <= capacity; w++) {
            if (i == 0 || w == 0)
                K[i][w] = 0;
            else if (weight[i - 1] <= w)
                K[i][w] = max(profit[i - 1] + K[i - 1][w - weight[i - 1]], K[i - 1][w]);
            else
                K[i][w] = K[i - 1][w];
        }
    }

    // Optional: Print the items included
    printf("\nItems included:\n");
    w = capacity;
    for (i = n; i > 0 && w > 0; i--) {
        if (K[i][w] != K[i - 1][w]) {
            printf("Item %d (Weight: %d, Profit: %d)\n", i, weight[i - 1], profit[i - 1]);
            w -= weight[i - 1];
        }
    }

    return K[n][capacity];
}
```

```
int main() {
    int n, capacity;
    int weight[50], profit[50];
    int i;

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

    printf("Enter weight and profit for each item:\n");
    for (i = 0; i < n; i++) {
        printf("Item[%d] - Weight Profit: ", i + 1);
        scanf("%d %d", &weight[i], &profit[i]);
    }

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

    int maxProfit = knapsack(weight, profit, n, capacity);

    printf("\nMaximum profit: %d\n", maxProfit);
    return 0;
}
```

Screenshot of Output

```
Enter number of items: 4
Enter weight and profit for each item:
Item[1] - Weight Profit: 2 12
Item[2] - Weight Profit: 3 15
Item[3] - Weight Profit: 1 25
Item[4] - Weight Profit: 2 10
Enter the capacity of knapsack: 4

Items included:
Item 3 (Weight: 1, Profit: 25)
Item 2 (Weight: 3, Profit: 15)

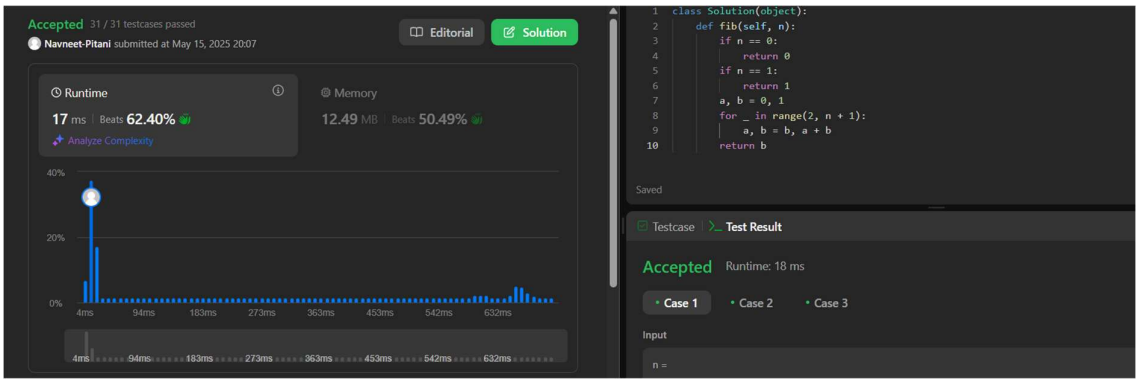
Maximum profit: 40
```

Lab program 9.2:

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
```

Screenshot of Output



Lab program 10:

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

Code

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


void heapify(int arr[], int n, int i) {
   int largest = i;
   int left = 2 * i + 1;
   int right = 2 * i + 2;


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


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


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


      heapify(arr, n, largest);
   }
}


void heapSort(int arr[], int n) {

   for (int i = n / 2 - 1; i >= 0; i--)
      heapify(arr, n, i);


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

      int temp = arr[0];
      arr[0] = arr[i];
      arr[i] = temp;


      heapify(arr, i, 0);
   }
}
```

```
int main() {
    int arr[1000], n;
    clock_t start, end;
    double time_taken;

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

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

    start = clock();

    heapSort(arr, n);

    end = clock();

    time_taken = ((double)(end - start)) / CLOCKS_PER_SEC;

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

    printf("\n\nTime taken by Heap Sort: %f seconds\n", time_taken);

    return 0;
}
```

Screenshot of Output

```
Enter number of elements: 7
Enter 7 integer elements:
50
25
30
75
100
45
80

Sorted array is:
25 30 45 50 75 80 100

Time taken by Heap Sort: 0.000000 seconds
```

Lab program 11.1:

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

Code

```
#include <stdio.h>


#define INF 99999  // Use a large number to represent infinity
#define MAX 100


void floydWarshall(int graph[MAX][MAX], int n) {
    int dist[MAX][MAX];
    int i, j, k;


    // Initialize the solution matrix same as input graph
    for (i = 0; i < n; i++)
        for (j = 0; j < n; j++)
            dist[i][j] = graph[i][j];
```

```
    // Floyd-Warshall algorithm
    for (k = 0; k < n; k++) {
        for (i = 0; i < n; i++) {
            for (j = 0; j < n; j++) {
                if (dist[i][k] + dist[k][j] < dist[i][j])
                    dist[i][j] = dist[i][k] + dist[k][j];
            }
        }
    }

    // Print the final shortest distance matrix
    printf("\nAll-Pairs Shortest Paths (Floyd-Warshall):\n");
    for (i = 0; i < n; i++) {
        for (j = 0; j < n; j++) {
            if (dist[i][j] == INF)
                printf("INF ");
            else
                printf("%3d ", dist[i][j]);
        }
        printf("\n");
    }
}

int main() {
    int graph[MAX][MAX], n;

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

```
    printf("Enter the adjacency matrix (use 99999 for no direct path):\n");
    for (int i = 0; i < n; i++) {
        for (int j = 0; j < n; j++) {
            scanf("%d", &graph[i][j]);
        }
    }
    floydWarshall(graph, n);

    return 0;
}
```

Screenshot of Output

```
Enter number of vertices: 4
Enter the adjacency matrix (use 99999 for no direct path):
0 4 3 9
99 0 1 99
99 990 99999
5 2 6 0
2 99 99999 99999

All-Pairs Shortest Paths (Floyd-Warshall):
  0   4   3   8
  8   0   1   6
  7  11   5   5
  2   6   0   2
```

Lab program 11.2:

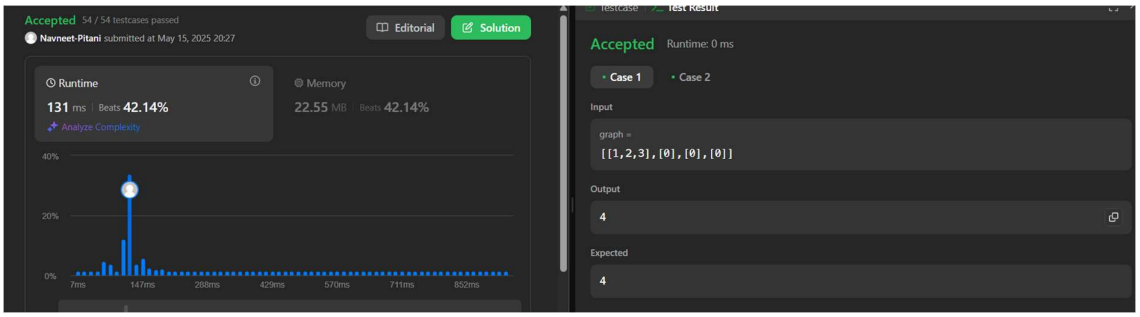
LeetCode Program related to shortest distance calculation

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
```

Screenshot of Output



Lab program 12:

Implement “N-Queens Problem” using Backtracking.

Code

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

#define MAX 20

int board[MAX];
int found = 0;
```

```
// Function to print one solution
void printSolution(int n) {
    printf("One solution for %d-Queens:\n", n);
    for (int i = 1; i <= n; i++) {
        for (int j = 1; j <= n; j++) {
            if (board[i] == j)
                printf("Q ");
            else
                printf(". ");
        }
        printf("\n");
    }
    found = 1;
}

// Check if placing queen at (k, i) is safe
int isSafe(int k, int i) {
    for (int j = 1; j < k; j++) {
        if (board[j] == i || fabs(board[j] - i) == fabs(j - k))
            return 0;
    }
    return 1;
}

// Recursive backtracking to find one solution
void nQueens(int k, int n) {
    for (int i = 1; i <= n && !found; i++) {
        if (isSafe(k, i)) {
```

```
            board[k] = i;
            if (k == n)
                printSolution(n);
            else
                nQueens(k + 1, n);
        }
    }
}

int main() {
    int n;
    printf("Enter number of queens (N): ");
    scanf("%d", &n);

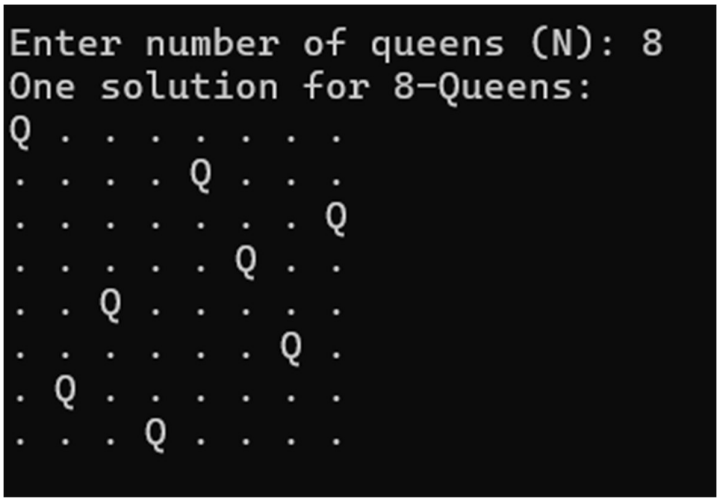
    if (n < 1 || n > MAX) {
        printf("Please enter N between 1 and %d.\n", MAX);
        return 1;
    }

    nQueens(1, n);

    if (!found)
        printf("No solution exists for N = %d\n", n);

    return 0;
}
```

Screenshot of Output


Enter number of queens (N): 8
One solution for 8-Queens:
Q . . . .
. . . . Q . . .
. . . . Q
. . . . . Q . .
. . Q . . . . .
. . . . . . Q .
. Q . . . . . .
. . . Q . . . .