VISVESVARAYA TECHNOLOGICAL UNIVERSITY

"JnanaSangama", Belgaum -590014, Karnataka.

LAB REPORT
On

ANALYSIS AND DESIGN OF ALGORITHMS (23CS4PCADA)

Submitted by

Hitesh Sharma (1BM23CS114)

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)
BENGALURU-560019
February-May 2025

B. M. S. College of Engineering,

This is to certify that the Lab work entitled **"ANALYSIS AND DESIGN OF ALGORITHMS"** carried out by **Hitesh Sharma (1BM23CS114)**
, 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.

Ramya K M   **Dr. Kavitha Sooda**
Assistant Professor   Professor and Head
Department of CSE   Department of CSE
BMSCE, Bengaluru   BMSCE, Bengaluru

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.

GITHUB LINK:

https://github.com/Hitesh6747/ADALAB

Lab program 1:

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

i)using dfs

CODE:

```c
#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) {
```
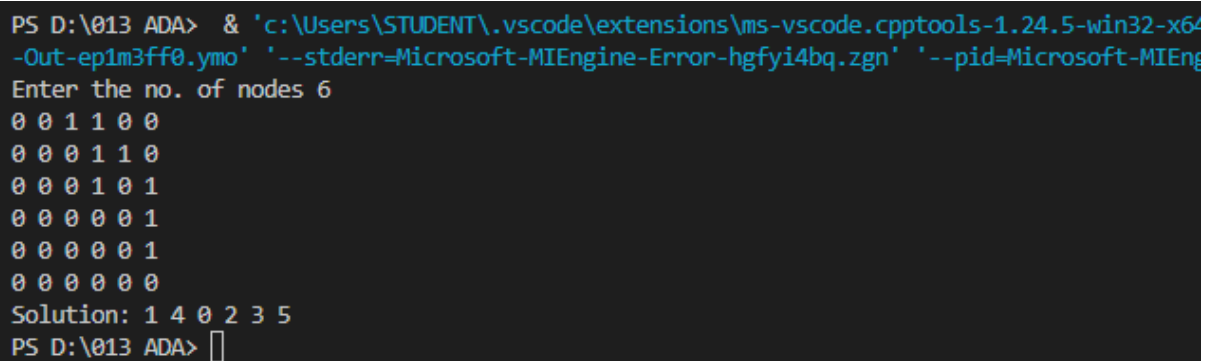
```
dfs(i, n, a);

}

}

}

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: ");
```

```c
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:


```
PS D:\013 ADA>  & 'c:\Users\STUDENT\.vscode\extensions\ms-vscode.cpptools-1.24.5-win32-x6
-Out-meh2oxyd.2f5' '--stderr=Microsoft-MIEngine-Error-nfn3nxgj.bzv' '--pid=Microsoft-MIEn
Enter the no. of nodes: 5
0 0 1 0 0
1 0 0 1 0
0 0 0 0 1
0 0 1 0 1
0 0 0 0 0
Solution:1 3 0 2 4
PS D:\013 ADA>
```

LeetCode Program related to Topological sorting

Course Schedule (207)

CODE:

```cpp
class Solution {
public:
    bool canFinish(int numCourses, vector<vector<int>>& prerequisites) {
        vector<vector<int>> graph(numCourses);
        vector<int> visited(numCourses, 0); // 0 = unvisited, 1 = visiting, 2 = visited

        for (auto& pre : prerequisites) {
            graph[pre[1]].push_back(pre[0]);
        }

        function<bool(int)> dfs = [&](int course) {
            if (visited[course] == 1) return false; // cycle detected
            if (visited[course] == 2) return true;  // already checked

            visited[course] = 1;
            for (int neighbor : graph[course]) {
                if (!dfs(neighbor)) return false;
            }
            visited[course] = 2;
            return true;
        };

        for (int i = 0; i < numCourses; ++i) {
            if (!dfs(i)) return false;
        }
```

```
        return true;

    }

};
```

OUTPUT:

};**OUTPUT:**
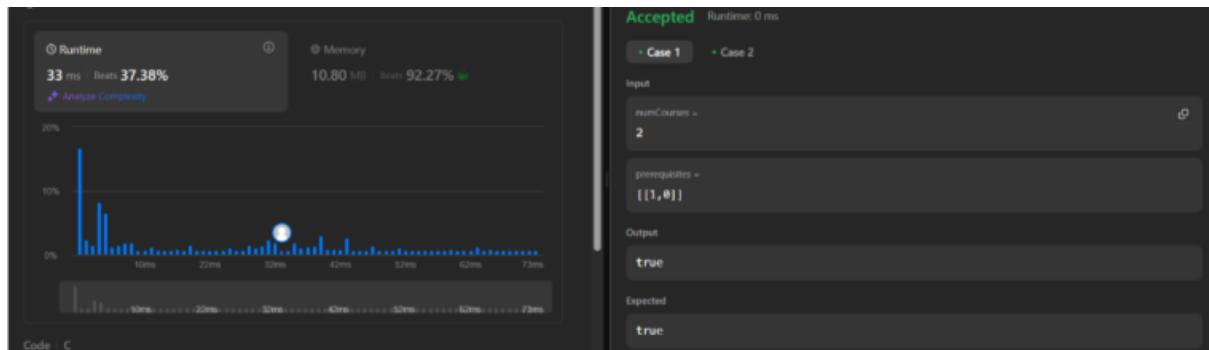
Lab program 2:

Implement Johnson Trotter algorithm to generate permutations.

CODE:

```c
#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:

```
PS D:\013 ADA>  & 'c:\Users\STUDENT\.vscode\extensions\ms-vscode.cpptools-1.24.5-win32-x64\debugAdapters\bin\Wi
-Out-jbouobin.0bh' '--stderr=Microsoft-MIEngine-Error-2dhrtqgc.w2m' '--pid=Microsoft-MIEngine-Pid-w4atb5is.vzb'
Enter the number of elements: 4
Enter the elements: 1 2 3 4
1 2 3 4
1 2 4 3
1 3 2 4
1 3 4 2
1 4 3 2
1 4 2 3
2 1 3 4
2 1 4 3
2 3 1 4
2 3 4 1
2 4 3 1
2 4 1 3
3 2 1 4
3 2 4 1
3 1 2 4
3 1 4 2
3 4 1 2
3 4 2 1
4 2 3 1
4 2 1 3
4 3 2 1
4 3 1 2
4 1 3 2
4 1 2 3
PS D:\013 ADA>
```

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:

```c
#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++;
        }
    }
```
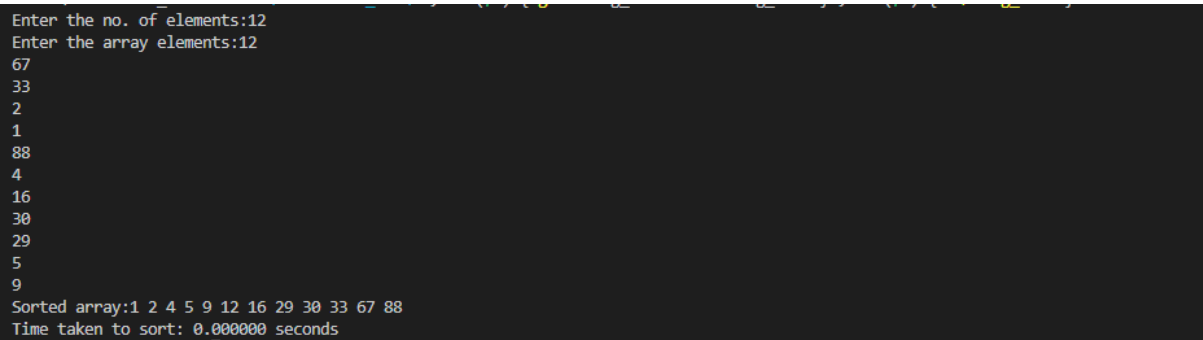
```c
    while(i<=mid){
      c[k++]=a[i];
      i++;
    }
    while(j<=high){
      c[k++]=a[j];
      j++;
    }
    for(i=low;i<=high;i++){
      a[i]=c[i];
    }
}
int main()
{
    int i;
    clock_t start, end;
    double time_taken;
    printf("Enter the no. of elements:");
    scanf("%d", &n);
    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:

```
Enter the no. of elements:12
Enter the array elements:12
67
33
2
1
88
4
16
30
29
5
9
Sorted array:1 2 4 5 9 12 16 29 30 33 67 88
Time taken to sort: 0.000000 seconds
```

Leetcode program related to merge sort

Count Sum (327)

CODE:

```cpp
class Solution {
public:
    int countRangeSum(vector<int>& nums, int lower, int upper) {
        int n = nums.size();
        vector<long> prefix(n + 1, 0);
        for (int i = 0; i < n; ++i)
            prefix[i + 1] = prefix[i] + nums[i];


        return countWhileMergeSort(prefix, 0, n + 1, lower, upper);
    }


private:
    int countWhileMergeSort(vector<long>& sums, int left, int right, int lower, int upper) {
        if (right - left <= 1) return 0;
        int mid = (left + right) / 2;
        int count = countWhileMergeSort(sums, left, mid, lower, upper) +
                countWhileMergeSort(sums, mid, right, lower, upper);


        int j = mid, k = mid, t = mid;
        vector<long> cache(right - left);
        int r = 0;


        for (int i = left; i < mid; ++i) {
            while (k < right && sums[k] - sums[i] < lower) k++;
            while (j < right && sums[j] - sums[i] <= upper) j++;
```

```cpp
        while (t < right && sums[t] < sums[i]) cache[r++] = sums[t++];

        cache[r++] = sums[i];

        count += j - k;

    }


    copy(cache.begin(), cache.begin() + r, sums.begin() + left);

    return count;

  }

};
```

OUTPUT:
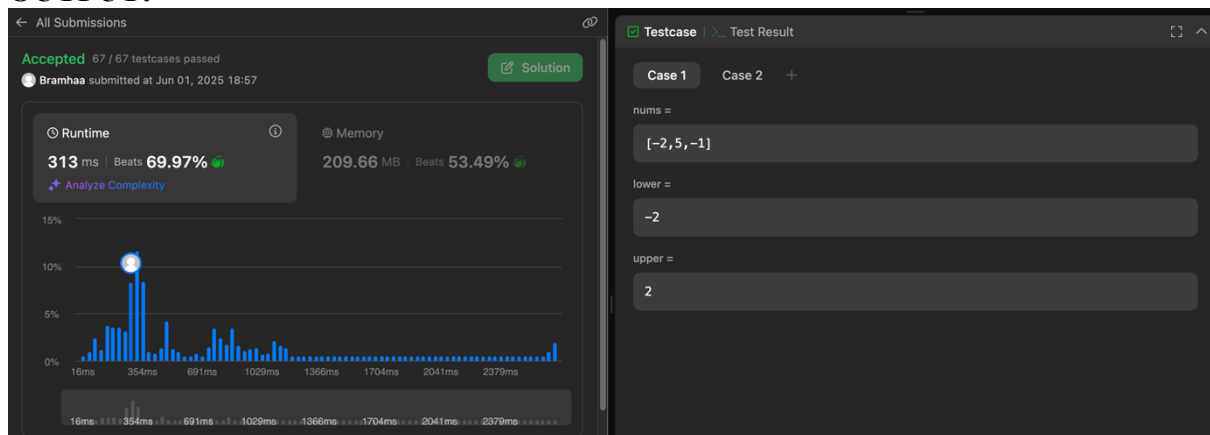
Lab program 4:

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

CODE:

```c
#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");
```

```c
    // 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:

```
Enter the number of elements: 6
The random generated array is:
41 67 134 100 169 124

The sorted array elements are:
41 67 100 124 134 169
Time taken = 0.000000 seconds

Do you wish to continue? (0/1): 0
```

Leetcode Program relaed to quicksort
Kth largest element in array (215)

CODE:

```cpp
class Solution {
public:
    int findKthLargest(vector<int>& nums, int k) {
        priority_queue<int, vector<int>, greater<int>> minHeap;
        for (int num : nums) {
            minHeap.push(num);
            if (minHeap.size() > k) minHeap.pop();
        }
        return minHeap.top();
    }
};
```

OUTPUT:
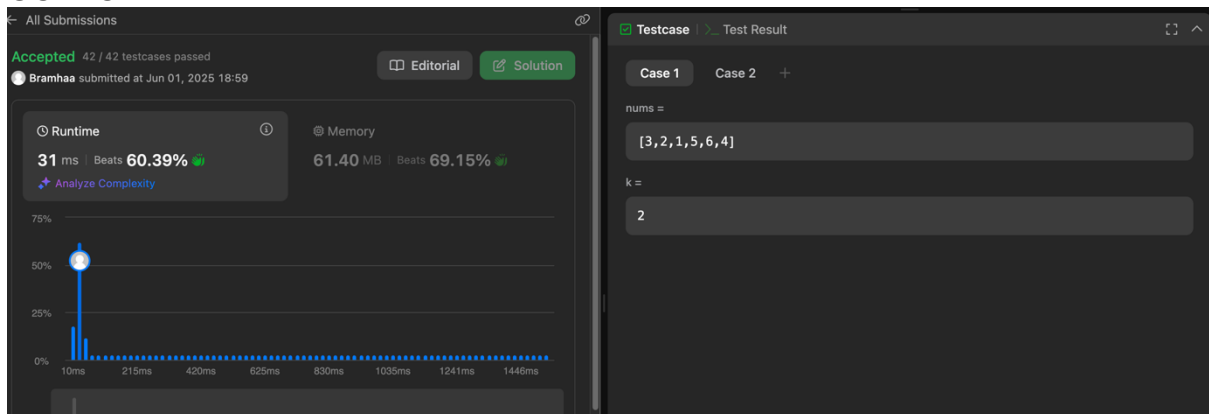
Lab program 5:

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

CODE:

```c
#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];
```

```c
        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);
```

```c
		}
	}
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:

```
 enter the number of elements to sort
5

 enter the elements to sort
8 5 6 3 1

 the sorted list of elemnts is
1
3
5
6
8

 Time taken is 0.000000 CPU cycles
do u wish to run again (0/1)
0
```

Lab program 6:

Implement 0/1 Knapsack problem using dynamic programming.

CODE:

```c
#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]);

}
```

```c
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:

```
Enter the no. of objects : 4

Enter the weights : 2
1
3
2

Enter the Profits : 12
10
20
15

Enter the capacity : 5


Maximum Profit is : 37


Table :
        0       0       0       0       0       0
        0       0       12      12      12      12
        0       10      12      22      22      22
        0       10      12      22      30      32
        0       10      15      25      30      37
```

LeetCode Program related to Knapsack problem or Dynamic Programming.

Pizza with 3n slices

CODE:

```cpp
class Solution {
public:
    int maxSizeSlices(vector<int>& slices) {
        int n = slices.size();
        return max(solve(slices, 0, n - 2, n / 3), solve(slices, 1, n - 1, n / 3));
    }

    int solve(vector<int>& slices, int left, int right, int pick) {
        int len = right - left + 1;
        vector<vector<int>> dp(pick + 1, vector<int>(len + 2, 0));

        for (int i = 1; i <= pick; ++i) {
            for (int j = 0; j < len; ++j) {
                int idx = left + j;
                dp[i][j + 2] = max(dp[i][j + 1], dp[i - 1][j] + slices[idx]);
            }
        }
        return dp[pick][len + 1];
    }
};
```
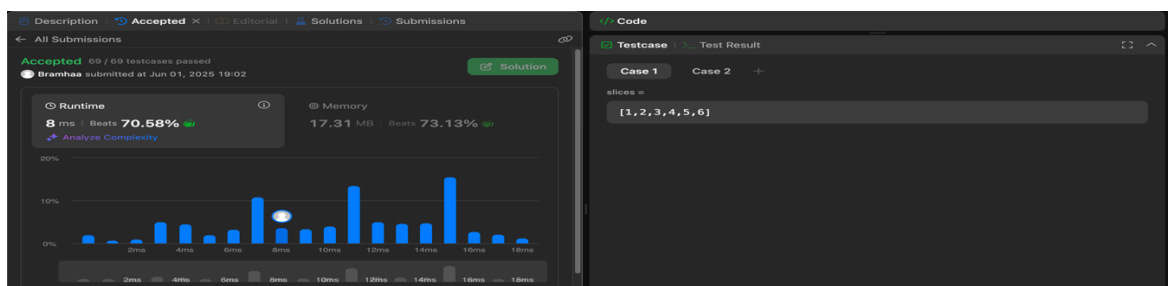
OUTPUT:

Lab program 7:

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

CODE:

```c
#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;

}
```

```c
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:

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

LeetCode Program related to shortest distance calculation.

Number of ways to arrive at destination (1976)

CODE:

```cpp
class Solution {
public:
    int countPaths(int n, vector<vector<int>>& roads) {
        const int MOD = 1e9 + 7;
        vector<vector<pair<int, int>>> graph(n);
        for (auto& r : roads) {
            graph[r[0]].emplace_back(r[1], r[2]);
            graph[r[1]].emplace_back(r[0], r[2]);
        }

        vector<long long> dist(n, LLONG_MAX);
        vector<int> ways(n, 0);
        priority_queue<pair<long long, int>, vector<pair<long long, int>>, greater<>> pq;

        dist[0] = 0;
        ways[0] = 1;
        pq.emplace(0, 0);

        while (!pq.empty()) {
            auto [d, u] = pq.top(); pq.pop();
            if (d > dist[u]) continue;

            for (auto& [v, w] : graph[u]) {
                long long newDist = d + w;
                if (newDist < dist[v]) {
                    dist[v] = newDist;
```
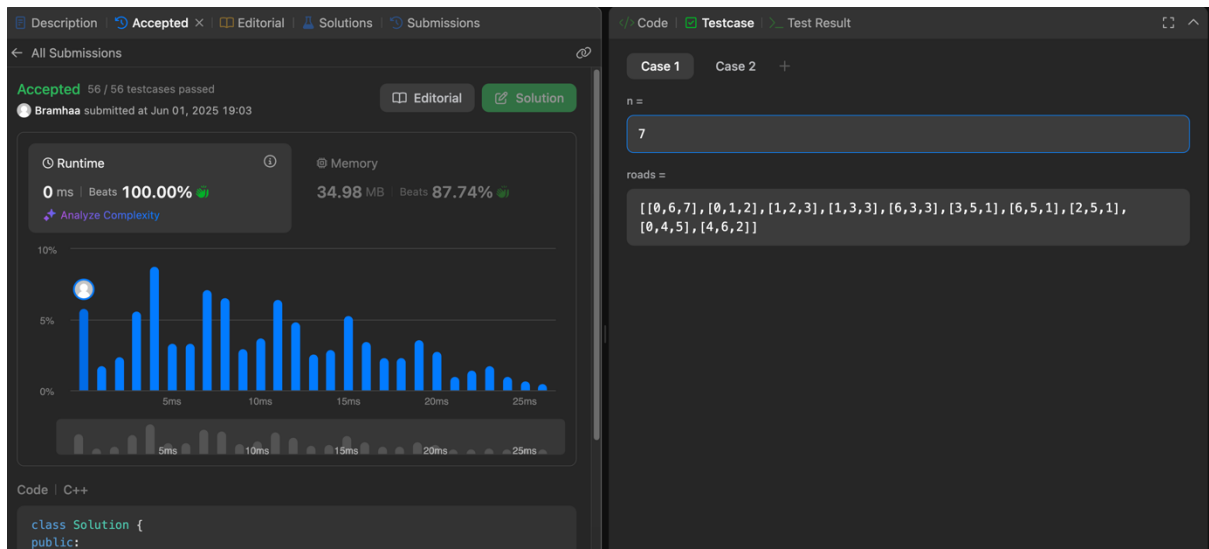
```cpp
                ways[v] = ways[u];

                pq.emplace(newDist, v);

            } else if (newDist == dist[v]) {

                ways[v] = (ways[v] + ways[u]) % MOD;

            }

        }

    }


    return ways[n - 1];

}
};
```

OUTPUT:

Lab program 8:

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

CODE:

```c
#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:

```
Enter the number of vertices: 5
Enter the cost adjacency matrix:

Edges of the minimal spanning tree:
(1, 0) (2, 0) (3, 0) (4, 0)
Sum of minimal spanning tree: 10
```

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

CODE:

```c
#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: 5
Enter the cost adjacency matrix:
0
1
2
3
4
1
0
3
5
7
2
3
0
3
9
3
5
3
0
7
4
7
9
7
0
Edges of the minimal spanning tree:
(0, 1) (0, 2) (0, 3) (0, 4)
Sum of minimal spanning tree: 10
```

Lab program 9:

Implement Fractional Knapsack using Greedy technique.

CODE:

```c
#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 {
```

```c
            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:

```
Enter the number of items: 7
Enter the weights of the items: 2 1 3 4 7 3 1
Enter the profits of the items: 3 4 6 8 3 7 2
Enter the capacity of the knapsack: 17
Total Profit = 31.29
```

OTUPUT:

LeetCode Program related to Greedy Technique algorithms.

Maximum units on truck(1710)
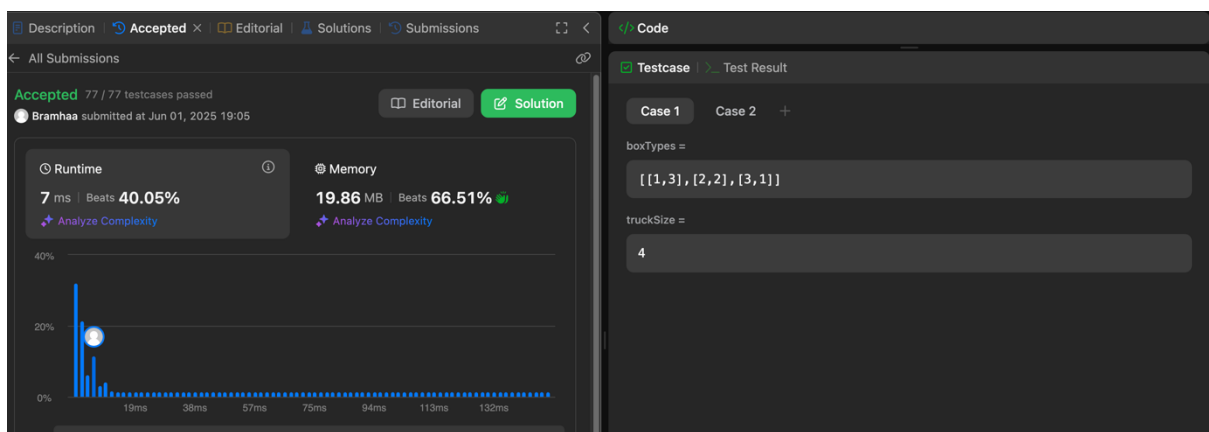
CODE:

```
class Solution {
public:
    int maximumUnits(vector<vector<int>>& boxTypes, int truckSize) {
        sort(boxTypes.begin(), boxTypes.end(), [](auto& a, auto& b) {
            return a[1] > b[1]; // sort by units per box in descending order
        });

        int totalUnits = 0;
        for (auto& box : boxTypes) {
            int count = min(truckSize, box[0]);
            totalUnits += count * box[1];
            truckSize -= count;
            if (truckSize == 0) break;
        }
        return totalUnits;
    }
};
```

OUTPUT:

Lab program 10:

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

CODE:

```c
#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++)

{
```

```c
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:

```
Enter the no. of vertices : 5

Enter the cost adjacency matrix :
Enter 999 for no edge 999
7
3
999
999
7
999
2
5
4
3
2
999
4
999
999
5
4
999
6
999
4
999
6
999

Enter the source vertex : 1

The shortest distance from 1 is
1 -->; 1 = 0
1 -->; 2 = 5
1 -->; 3 = 3
1 -->; 4 = 7
1 -->; 5 = 9
```

Lab program 11:

Implement "N-Queens Problem" using Backtracking.

CODE:

```c
#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++;
```

```c
                        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:

```
 enter the number of queens to be placed
 4

 1 solution
        1 row <---> 2 column
        2 row <---> 4 column
        3 row <---> 1 column
        4 row <---> 3 column
 2 solution
        1 row <---> 3 column
        2 row <---> 1 column
        3 row <---> 4 column
        4 row <---> 2 column_
```