VISVESVARAYA TECHNOLOGICAL UNIVERSITY

"JnanaSangama", Belgaum -590014, Karnataka.

LAB REPORT

on

Analysis and Design of Algorithms

Submitted by

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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

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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

CERTIFICATE

This is to certify that the Lab work entitled "Analysis and Design of Algorithms" carried out by **SUFIYAN DESAI (1BM22CS351) ,** 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 academic semester April-2024 to August-2024. The Lab report has been approved as it satisfies the academic requirements in respect of an Analysis and Design of Algorithms (23CS4PCADA) work prescribed for the said degree.

Madhavi R.P	Dr. Jyothi S Nayak
Associate Professor	Professor and Head
Department of CSE	Department of CSE
BMSCE, Bengaluru	BMSCE, Bengaluru

Index Sheet

10	From a given vertex in a weighted connected graph, find shortest paths to other vertices using Dijkstra's algorithm.	39-50
	Find Minimum Cost Spanning Tree of a given undirected graph using Kruskal's algorithm. Implement Fractional Knapsack using Greedy technique. Implement "N-Queens Problem" using Backtracking.	

Course Outcome

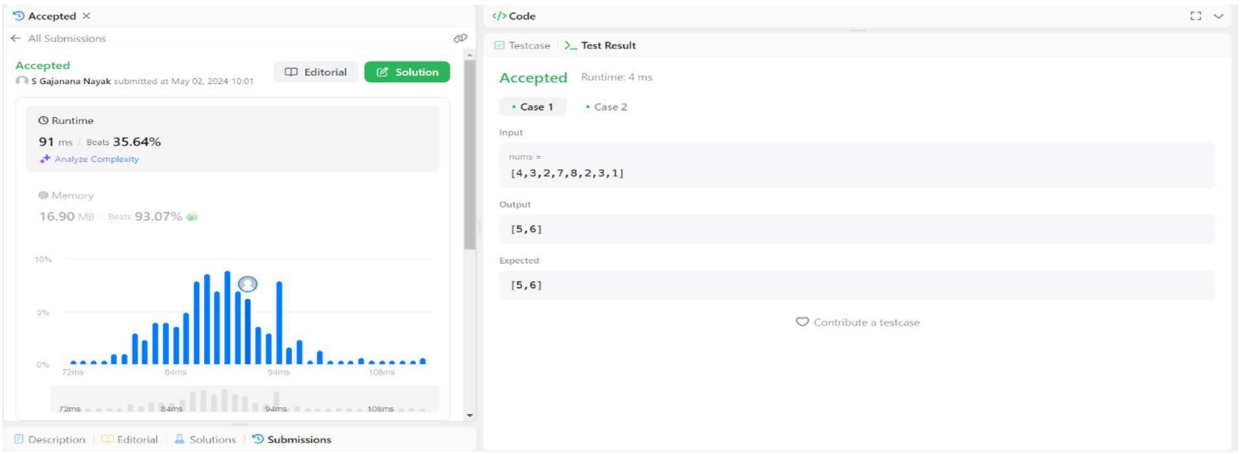
CO1	Analyze time complexity of Recursive and Non-recursive algorithms using asymptotic notations.
CO2	Apply various design techniques for the given problem.
CO3	Apply the knowledge of complexity classes P, NP, and NP-Complete and prove certain problems are NP-Complete
CO4	Design efficient algorithms and conduct practical experiments to solve problems.

LAB-1 :

Leetcode-1 : Find Disappeared Numbers in the array

```
int* findDisappearedNumbers(int* nums, int numsSize, int* returnSize) {
int temp = 0;     for (int index = 0; index < numsSize; ++index) {
temp = abs(nums[index]) - 1;         nums[temp] = abs(nums[temp]) * -1;
   }     int insert_index = 0;     *returnSize = 0;
for (int index = 0; index < numsSize; ++index) {
if (nums[index] > 0) {             ++*returnSize;
nums[insert_index++] = index + 1;
      }
   }
   return nums;
}
```

Output:

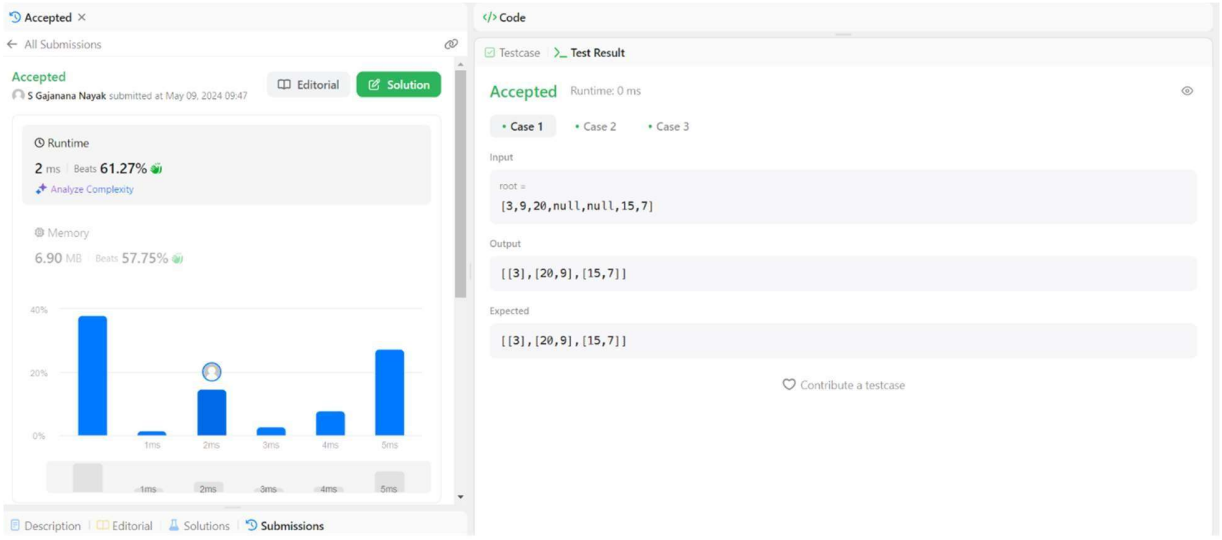


LAB-2 :

Leetcode-2: Zigzag Traversal of BST

```
int** zigzagLevelOrder(struct TreeNode* root, int* returnSize, int** returnColumnSizes) {
int **ans = malloc(2000*sizeof(int*));
   *returnColumnSizes = malloc(2000*sizeof(int));
   *returnSize = 0;     struct TreeNode
*tmp[2000] ={0};
   int top = -1, start = 0;
tmp[++top] = root;
while(tmp[start])
   {        int tmp_top = top;        ans[(*returnSize)] =
malloc((top-start+1)*sizeof(int));
(*returnColumnSizes)[(*returnSize)] = (top-start+1);
int idx = (*returnSize)%2 ? (top-start+1)-1:0;        int step
=  (*returnSize)%2 ? -1:1;        while(start <= tmp_top)
       {
          ans[(*returnSize)][idx] = tmp[start]->val;
if(tmp[start]->left)                tmp[++top]
=tmp[start]->left;             if(tmp[start]->right)
tmp[++top] =tmp[start]->right;            start++;
idx += step;
       }
       (*returnSize)++;
   }     return
ans;
}
```

Output:

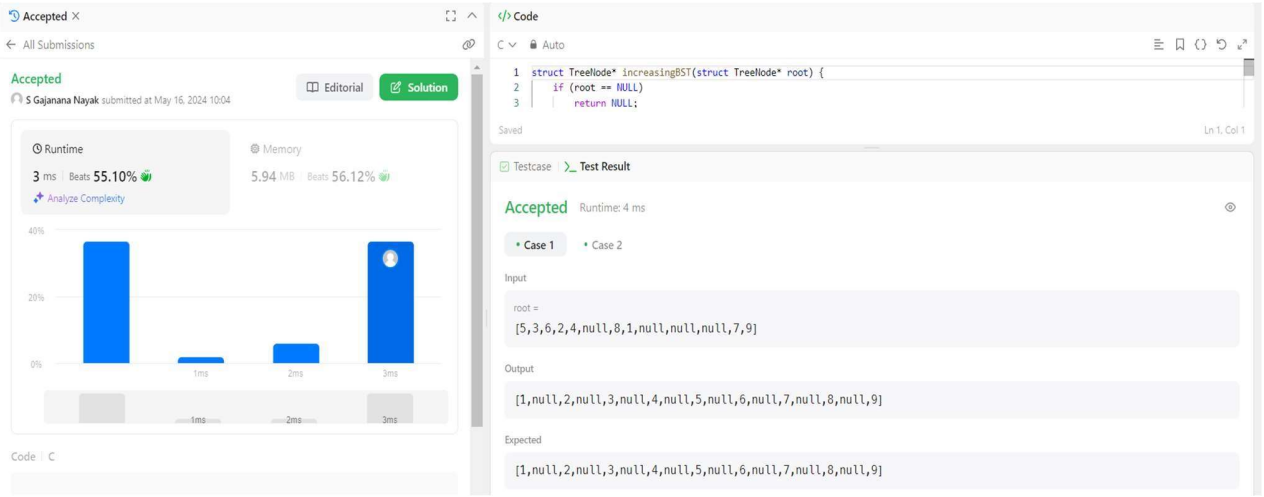

Accepted
All Submissions
Accepted
S Gajanana Nayak submitted at May 09, 2024 09:47
Editorial
Solution
Runtime
2 ms | Beats 61.27%
Analyze Complexity
Memory
6.90 MB | Beats 57.75%
40%
20%
0%
1ms
2ms
3ms
4ms
5ms
Description
Editorial
Solutions
Submissions
Code
Testcase
Test Result
Accepted
Runtime: 0 ms
Case 1
Case 2
Case 3
Input
root =
[3,9,20,null,null,15,7]
Output
[[3],[20,9],[15,7]]
Expected
[[3],[20,9],[15,7]]
Contribute a testcase

LAB-3 :

Leetcode-3: Increasing Order Search Tree

```
struct TreeNode* increasingBST(struct TreeNode* root) {
if (root == NULL)        return NULL;     struct TreeNode*
newRoot = NULL;     struct TreeNode* prev = NULL;
struct TreeNode* curr = root;     struct TreeNode*
stack[2000];     int top = -1;

   while (curr != NULL || top != -1) {
while (curr != NULL) {
stack[++top] = curr;            curr = curr-
>left;
      }        curr = stack[top--];
if (newRoot == NULL) {
newRoot = curr;
      } else {            prev-
>right = curr;
      }        prev = curr;
curr->left = NULL;
curr = curr->right;
   }
   return newRoot;
}
```

Output:


Accepted
All Submissions
Accepted
S Gajanana Nayak submitted at May 16, 2024 10:04
Editorial
Solution
Runtime
3 ms | Beats 55.10%
Analyze Complexity
Memory
5.94 MB | Beats 56.12%
40%
20%
0%
1ms
2ms
3ms
Code | C
Code
C
Auto
1 struct TreeNode* increasingBST(struct TreeNode* root) {
2 if (root == NULL)
3 return NULL;
Saved
Ln 1, Col 1
Testcase
Test Result
Accepted
Runtime: 4 ms
Case 1
Case 2
Input
root =
[5,3,6,2,4,null,8,1,null,null,null,7,9]
Output
[1,null,2,null,3,null,4,null,5,null,6,null,7,null,8,null,9]
Expected
[1,null,2,null,3,null,4,null,5,null,6,null,7,null,8,null,9]

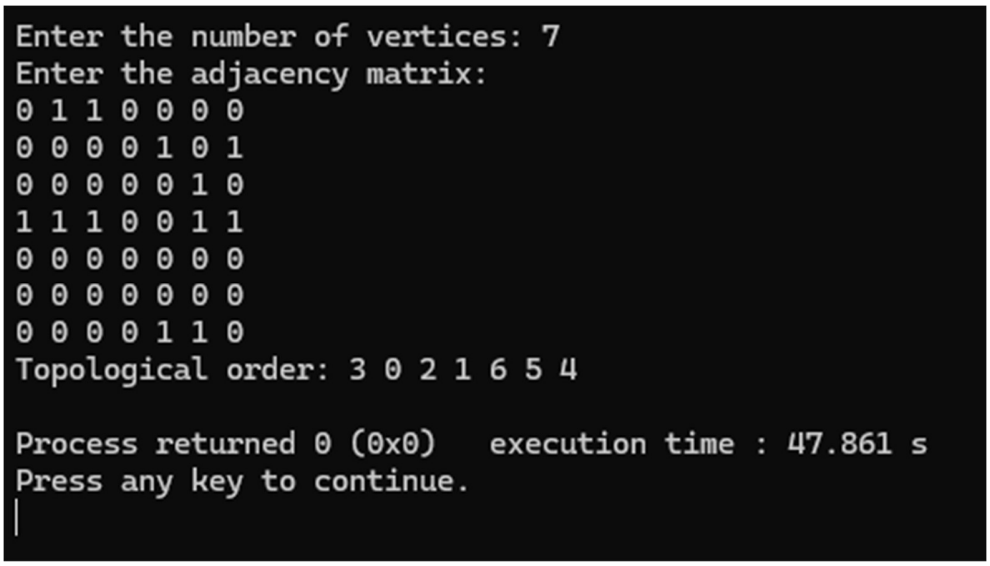
LAB-4 :

Topological ordering using DFS

```
#include <stdio.h>
#include <stdlib.h>
#define MAX_VERTICES 100

int s[MAX_VERTICES] = {0}; int
res[MAX_VERTICES];
int j = 0;
void DFS(int u, int n, int a[MAX_VERTICES][MAX_VERTICES]) {
   s[u] = 1;     for (int v = 0; v < n;
v++) {        if (a[u][v] == 1 && s[v]
== 0) {
          DFS(v, n, a);
       }
}
   res[j++] = u;
} int main()
{
   int n;
   printf("Enter the number of vertices: ");
scanf("%d", &n);
   int a[MAX_VERTICES][MAX_VERTICES];
   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]);
       }
   }
```

```
    for (int u = 0; u < n; u++) {
if (s[u] == 0) {
            DFS(u, n, a);
        }
    }
    printf("Topological order: ");
    for (int i = j - 1; i >= 0; i--) {
printf("%d ", res[i]);
    }
printf("\n");

    return 0;
}
```

Output:



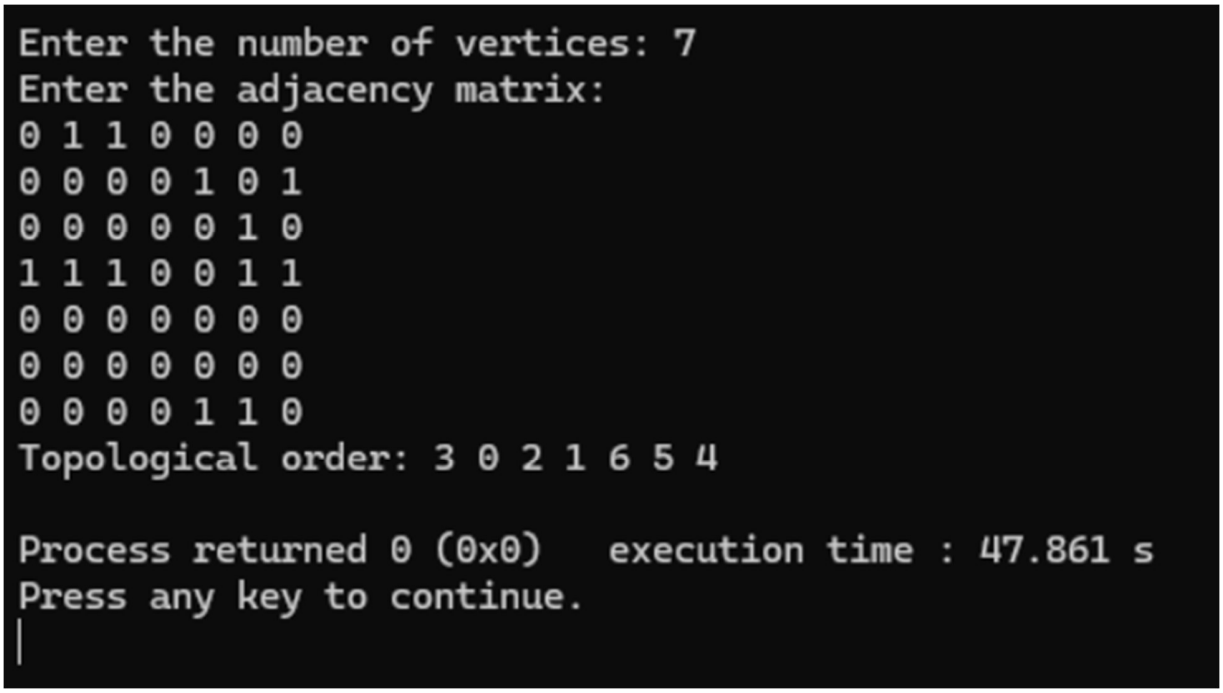
Topological sorting using Source Removal Method

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

```
int st[100]; int
top = -1;

void degree(int adj[][20], int n) {
int indegree[20];     int sum = 0;
for (int j = 0; j < n; j++) {
sum = 0;         for (int i = 0; i < n;
i++) {             sum = sum +
adj[i][j];
        }
        indegree[j] = sum;
    }
    for (int i = 0; i < n; i++) {
if (indegree[i] == 0) {
top++;             st[top] = i;
        }
    }

    while (top != -1) {
        int u = st[top];
top--;
        printf("%d ", u);         for
(int v = 0; v < n; v++) {
if (adj[u][v] == 1) {
indegree[v]--;                 if
(indegree[v] == 0) {
                    top++;
st[top] = v;
                }
```

```
            }
        }
    }
} int main()
{
    int n;
    printf("Enter the number of nodes: ");
scanf("%d", &n);

    int adj[20][20];

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

    return 0;
}
```

Output:



LAB-5 :

Merge Sort

```
#include<stdio.h>
#include<time.h>
#include<stdlib.h>
void split(int[],int,int); void
combine(int[],int,int,int); void
main()
{    int a[15000],n, i,j,ch,
temp;    clock_t start,end;
while(1)
  {
 printf("\n1:For manual entry of N value and array elements");  printf("\n2:To display time taken for sorting number of elements N in the range 500 to 14500");
```

```
 printf("\n3:To exit");
printf("\nEnter your choice:");
scanf("%d", &ch);      switch(ch)
    {
      case 1:  printf("\nEnter the number of elements: ");
                    scanf("%d",&n);
                    printf("\nEnter array elements: ");
                    for(i=0;i<n;i++)
                     {
                      scanf("%d",&a[i]);
                     }
                    start=clock();
split(a,0,n-1);
                    end=clock();
                    printf("\nSorted array is: ");
                    for(i=0;i<n;i++)
                    printf("%d\t",a[i]);
printf("\n      Time      taken      to      sort      %d      numbers      is      %f      Secs",n,
(((double)(endstart))/CLOCKS_PER_SEC));
                    break;
    case 2:
                n=500;
while(n<=14500) {
for(i=0;i<n;i++)
                     {
                       //a[i]=random(1000);
   a[i]=n-i;
                     }
               start=clock();
```

```
                split(a,0,n-1);
        //Dummy loop to create delay
            for(j=0;j<90000000;j++){ temp=38/600;}
end=clock();
printf("\n Time taken to sort %d numbers is %f Secs",n,
(((double)(endstart))/CLOCKS_PER_SEC));          n=n+1000;
                    }
               break;
  case 3: exit(0);
  }
  getchar();
   }
} void split(int a[],int low,int
high)
{  int mid;
if(low<high)
 {
  mid=(low+high)/2;
  split(a,low,mid);
split(a,mid+1,high);
combine(a,low,mid,high);
 }
}

void combine(int a[],int low,int mid,int high)
{  int
c[15000],i,j,k;
 i=k=low;
 j=mid+1;  while(i<=mid&&j<=high)
```

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

{

a[i]=c[i];

}

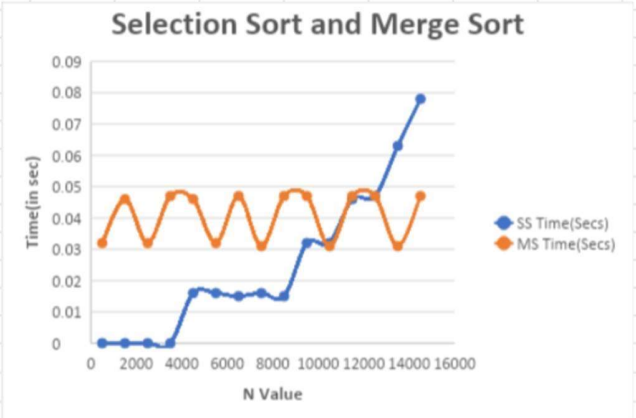
}

Output:

```
Enter the number of elements: 4

Enter array elements: 44 33 22 11

Sorted array is: 11     22      33      44
 Time taken to sort 4 numbers is 0.000000 Secs
1:For manual entry of N value and array elements
2:To display time taken for sorting number of elements N in the range 500 to 14500
3:To exit
Enter your choice:2

 Time taken to sort 500 numbers is 0.032000 Secs
 Time taken to sort 1500 numbers is 0.046000 Secs
 Time taken to sort 2500 numbers is 0.032000 Secs
 Time taken to sort 3500 numbers is 0.047000 Secs
 Time taken to sort 4500 numbers is 0.046000 Secs
 Time taken to sort 5500 numbers is 0.032000 Secs
 Time taken to sort 6500 numbers is 0.047000 Secs
 Time taken to sort 7500 numbers is 0.031000 Secs
 Time taken to sort 8500 numbers is 0.047000 Secs
 Time taken to sort 9500 numbers is 0.047000 Secs
 Time taken to sort 10500 numbers is 0.031000 Secs
 Time taken to sort 11500 numbers is 0.047000 Secs
 Time taken to sort 12500 numbers is 0.047000 Secs
 Time taken to sort 13500 numbers is 0.031000 Secs
 Time taken to sort 14500 numbers is 0.047000 Secs
1:For manual entry of N value and array elements
2:To display time taken for sorting number of elements N in the range 500 to 14500
3:To exit
Enter your choice:3

Process returned 0 (0x0)   execution time : 95.566 s
Press any key to continue.
```

Graph:

N value	SS Time(Secs)	MS Time(Secs)
500	0	0.032
1500	0	0.046
2500	0	0.032
3500	0	0.047
4500	0.016	0.046
5500	0.016	0.032
6500	0.015	0.047
7500	0.016	0.031
8500	0.015	0.047
9500	0.032	0.047
10500	0.032	0.031
11500	0.046	0.047
12500	0.047	0.047
13500	0.063	0.031
14500	0.078	0.047



LAB 6:

Quick Sort:

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

void swap(int *a, int *b){
int temp = *a;     *a = *b;
   *b = temp;
}

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

   while (i <= j) {         while (i <= j
&& a[i] <= pivot)
          i++;
       while (i <= j && a[j] > pivot)
          j--;
if (i < j)
          swap(&a[i], &a[j]);
   }

   swap(&a[low], &a[j]);
   return j;
}

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

```
   int point;     if(low<high){
point=partition(a,low,high);
quicksort(a,low,point-1);
quicksort(a,point+1,high);

   }

}
void main(){
   int a[15000], n, i, j, ch, temp;
clock_t start, end;

   while (1) {         printf("\n 1:For manual entry of N value and
array elements");
       printf("\n 2:To display time taken for sorting number of elements N in the range 500 to
14500");
       printf("\n 3:To exit");
       printf("\nEnter your choice:");
scanf("%d", &ch);

       switch (ch) {
          case 1:
             printf("\nEnter the number of elements: ");
scanf("%d", &n);                printf("Enter array
elements: ");                for (i = 0; i < n; i++) {
scanf("%d", &a[i]);
             }
             start = clock();
quicksort(a,0,n-1);                end =
clock();              printf("\nSorted
```

```
array is: ");                for (i = 0; i < n;
i++) {                    printf("%d\t",
a[i]);
            }
            printf("\nTime taken to sort %d numbers is %f Secs", n, (((double)(end - start)) /
CLOCKS_PER_SEC));
            break;


        case 2:
            n = 500;               while
(n <= 14500) {                  for (i =
0; i < n; i++) {                   a[i]
= n - i;
                }
                start = clock();
quicksort(a, 0, n - 1);                  for (j
= 0; j < 500000; j++) {
temp = 38 / 600;
                }
                end = clock();
                printf("\nTime taken to sort %d numbers is %f Secs", n, (((double)(end - start)) /
CLOCKS_PER_SEC));
                n = n + 1000;
            }
break;


        case 3:
            exit(0);
    }
    getchar();
  }
```

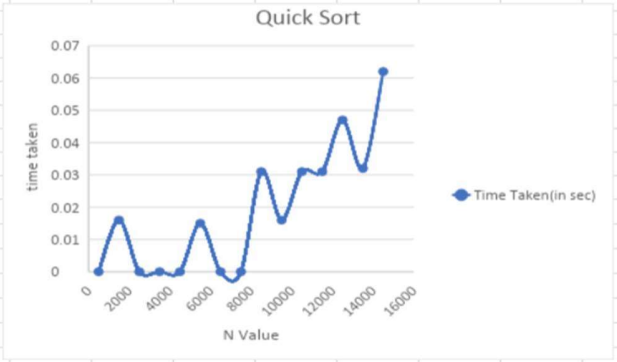
}

Output:

```
 1:For manual entry of N value and array elements
 2:To display time taken for sorting number of elements N in the range 500 to 14500
 3:To exit
Enter your choice:1

Enter the number of elements: 8
Enter array elements: 5 3 1 9 8 2 4 7

Sorted array is: 1      2       3       4       5       7       8       9
Time taken to sort 8 numbers is 0.000000 Secs
 1:For manual entry of N value and array elements
 2:To display time taken for sorting number of elements N in the range 500 to 14500
 3:To exit
Enter your choice:2

Time taken to sort 500 numbers is 0.000000 Secs
Time taken to sort 1500 numbers is 0.016000 Secs
Time taken to sort 2500 numbers is 0.000000 Secs
Time taken to sort 3500 numbers is 0.000000 Secs
Time taken to sort 4500 numbers is 0.000000 Secs
Time taken to sort 5500 numbers is 0.015000 Secs
Time taken to sort 6500 numbers is 0.000000 Secs
Time taken to sort 7500 numbers is 0.000000 Secs
Time taken to sort 8500 numbers is 0.031000 Secs
Time taken to sort 9500 numbers is 0.016000 Secs
Time taken to sort 10500 numbers is 0.031000 Secs
Time taken to sort 11500 numbers is 0.031000 Secs
Time taken to sort 12500 numbers is 0.047000 Secs
Time taken to sort 13500 numbers is 0.032000 Secs
Time taken to sort 14500 numbers is 0.062000 Secs
 1:For manual entry of N value and array elements
 2:To display time taken for sorting number of elements N in the range 500 to 14500
 3:To exit
Enter your choice:3

Process returned 0 (0x0)   execution time : 33.657 s
Press any key to continue.
```

Graph:

N-Value	Time Taken(in sec)
500	0
1500	0.016
2500	0
3500	0
4500	0
5500	0.015
6500	0
7500	0
8500	0.031
9500	0.016
10500	0.031
11500	0.031
12500	0.047
13500	0.032
14500	0.062



LAB 7:

Johnson Trotter Algorithm:

```
#include <stdio.h> #include
<stdlib.h>
int flag = 0; int
swap(int *a,int *b) {
int t =*a;     *a = *b;
   *b = t; } int search(int arr[],int
num,int mobile)
{    int
g;
   for(g=0; g<num; g++) {
      if(arr[g] == mobile)
return g+1;
      else          {
flag++;
      }
}
   return   -1;   }   int   find_Moblie(int
arr[],int d[],int num)
{    int mobile = 0;
int mobile_p =0;
   int i;
```

```
   for(i=0; i<num; i++) {
      if((d[arr[i]-1] == 0) && i != 0) {
if(arr[i]>arr[i-1] && arr[i]>mobile_p) {
            mobile = arr[i];
mobile_p = mobile;
         }          else          {
flag++;
         }
      } else if((d[arr[i]-1] == 1) & i != num-1) {
if(arr[i]>arr[i+1] && arr[i]>mobile_p) {
            mobile = arr[i];
mobile_p = mobile;
         }          else          {
flag++;         }      }      else
{          flag++;
      }
   }
   if((mobile_p == 0) && (mobile == 0))        return 0;
   else        return mobile;
}

void permutations(int arr[],int d[],int num)
{
   int i;
   int mobile = find_Moblie(arr,d,num);     int pos =
search(arr,num,mobile);     if(d[arr[pos-1]-1]==0)
swap(&arr[pos-1],&arr[pos-2]);
   else
      swap(&arr[pos-1],&arr[pos]);
```

```
   for(int i=0; i<num; i++) {         if(arr[i] >
mobile) {            if(d[arr[i]-1]==0)
d[arr[i]-1] = 1;             else                d[arr[i]-1] =
0;
       }
   }
   for(i=0; i<num; i++) {
printf(" %d ",arr[i]);
   }
}

int factorial(int k)
{     int f =
1;     int i =
0;
   for(i=1; i<k+1; i++) {
       f = f*i;
}     return f; }
int main() {
int num =0;
   int i;
int j;
   int z =0;     printf("Johnson trotter algorithm to find all permutations of given
numbers \n");     printf("Enter the number\n");     scanf("%d",&num);     int
arr[num],d[num];
   z = factorial(num);     printf("total
permutations = %d",z);     printf("\nAll
possible permutations are: \n");     for(i=0;
i<num; i++) {
```

```
        d[i] = 0;         arr[i]
= i+1;         printf(" %d
",arr[i]);
    }
    printf("\n");     for(j=1; j<z;
j++) {
permutations(arr,d,num);
        printf("\n");
    }
    return 0;
}
```

Output:

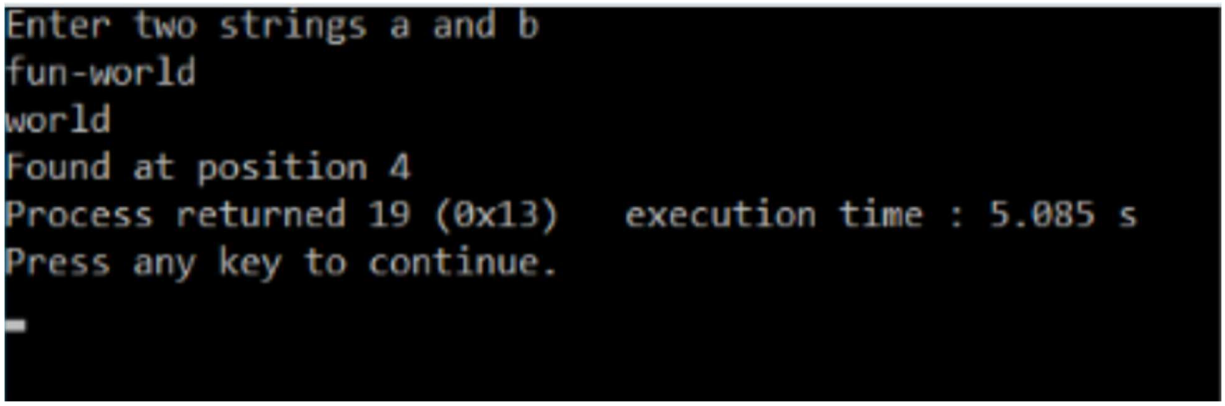
```
Johnson trotter algorithm to find all permutations of given numbers
Enter the number
3
total permutations = 6
All possible permutations are:
 1  2  3
 1  3  2
 3  1  2
 3  2  1
 2  3  1
 2  1  3
```

Pattern Matching Program:

```
#include<stdio.h> #include<string.h>
void main() {     char a[50], b[50];
printf("Enter two strings a and b\n");
scanf("%s",a);     scanf("%s",b);     int n
```

```
= strlen(a);     int m = strlen(b);     int j,
flag = 0;

   for(int i = 0; i <= n-m; i++)
   {        j
= 0;
       while(j < m && a[i+j] == b[j])
          j = j + 1;

          if(j == m)
{
              printf("%d\n",j);
flag = 1;
printf("%d",i);                break;
          }
}
   if(flag == 0)        printf("String
not matched");

}
```

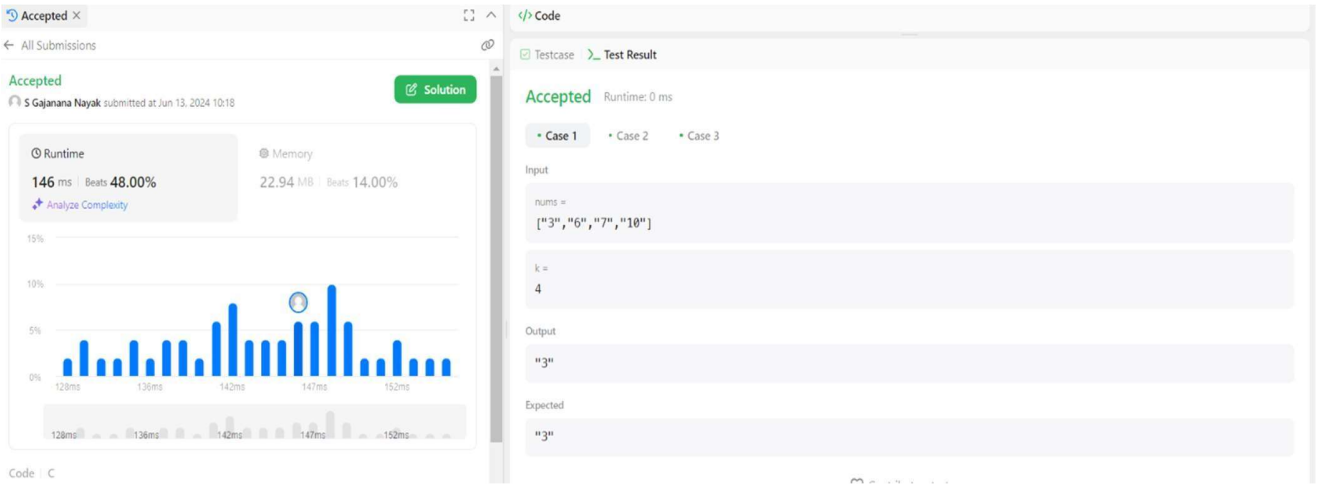
Output:



Leetcode-4: Find kth Largest Integer in the array:

```
int cmp(const void*a,const void*b) {
const char* str1 = *(const char**)a;
const char* str2 = *(const char**)b;

   if (strlen(str1) == strlen(str2)) {
return strcmp(str1, str2);
   }
   return strlen(str1) - strlen(str2);
}
char * kthLargestNumber(char ** nums, int numsSize, int k){
qsort(nums,numsSize,sizeof(char*),cmp); return
nums[numsSize-k];
}
```

Output:



LAB 8:

Heap Sort:

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

```
void bottom_up_heapify(int n, int a[]);
void swap(int *a, int *b); void
heap_sort(int n, int a[]);

void bottom_up_heapify(int n, int a[]) {
   int p, item, c;     for (p = (n-
1)/2; p >= 0; p--) {         item =
a[p];         c = 2 * p + 1;

       while (c <= n - 1) {             if (c + 1 <= n
- 1 && a[c] < a[c + 1]) {
              c++;
          }
          if (item >= a[c]) {
break;             }
          a[p] = a[c];
p = c;             c = 2 *
p + 1;         }
a[p] = item;
   }
}

void swap(int *a, int *b) {
int temp = *a;     *a = *b;
   *b = temp;
}

void heap_sort(int n, int a[]) {
   int i;
   bottom_up_heapify(n, a);
```

```
   for (i = n - 1; i >= 0; i--) {
swap(&a[0], &a[i]);
bottom_up_heapify(i, a);
   }
} int main() {     int a[15000], n,
i, j, ch, temp;     clock_t start,
end;     while (1) {

       printf("\n1: For manual entry of N value and array elements");
       printf("\n2: To display time taken for sorting number of elements N in the range 500 to
14500");
       printf("\n3: To exit");
printf("\nEnter your choice: ");
scanf("%d", &ch);         switch (ch)
{
          case 1:
             printf("\nEnter the number of elements: ");
scanf("%d", &n);                 printf("\nEnter array
elements: ");                 for (i = 0; i < n; i++) {
scanf("%d", &a[i]);
             }
             start = clock();
heap_sort(n, a);                 end =
clock();                printf("\nSorted
array is: ");                 for (i = 0; i < n;
i++)                 printf("%d\t", a[i]);
             printf("\nTime taken to sort %d numbers is %f Secs", n, (((double)(end - start)) /
CLOCKS_PER_SEC));
             break;


          case 2:
```

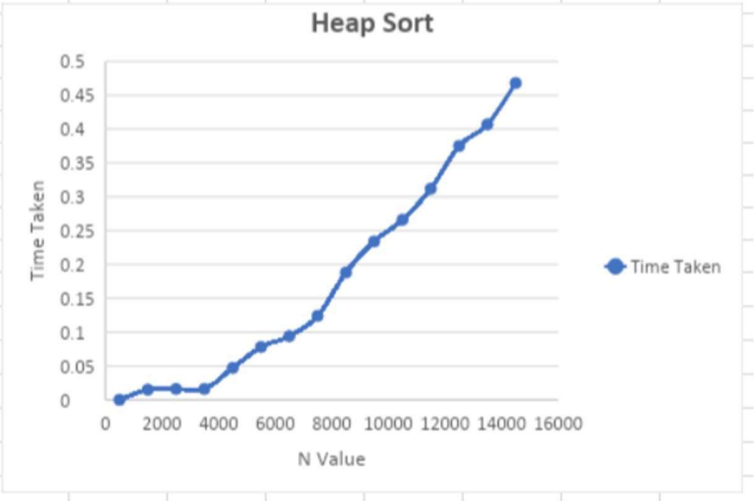
```
            n = 500;                while (n
<= 14500) {                 for (i = 0; i
< n; i++) {                  //a[i] =
rand() % 1000;                      a[i] = n
- i;

                }
                start = clock();
heap_sort(n, a);
                //Dummy loop to create delay
for (j = 0; j < 500000; j++) {
temp = 38 / 600;
                }
end = clock();
                printf("\nTime taken to sort %d numbers is %f Secs", n, (((double)(end - start)) /
CLOCKS_PER_SEC));
                n = n + 1000;
            }
break;
case 3:
            exit(0);
      }
      getchar();
   }
   return 0;
}
```

Output:

```
1: For manual entry of N value and array elements
2: To display time taken for sorting number of elements N in the range 500 to 14500
3: To exit
Enter your choice: 1

Enter the number of elements: 11

Enter array elements: 5 35 25 45 30 55 25 45 50 10 30

Sorted array is: 5      10      25      25      30      30      35      45      45      50      55
Time taken to sort 11 numbers is 0.000000 Secs
1: For manual entry of N value and array elements
2: To display time taken for sorting number of elements N in the range 500 to 14500
3: To exit
Enter your choice: 2

Time taken to sort 500 numbers is 0.000000 Secs
Time taken to sort 1500 numbers is 0.015000 Secs
Time taken to sort 2500 numbers is 0.016000 Secs
Time taken to sort 3500 numbers is 0.016000 Secs
Time taken to sort 4500 numbers is 0.047000 Secs
Time taken to sort 5500 numbers is 0.078000 Secs
Time taken to sort 6500 numbers is 0.094000 Secs
Time taken to sort 7500 numbers is 0.124000 Secs
Time taken to sort 8500 numbers is 0.188000 Secs
Time taken to sort 9500 numbers is 0.234000 Secs
Time taken to sort 10500 numbers is 0.266000 Secs
Time taken to sort 11500 numbers is 0.312000 Secs
Time taken to sort 12500 numbers is 0.375000 Secs
Time taken to sort 13500 numbers is 0.407000 Secs
Time taken to sort 14500 numbers is 0.468000 Secs
1: For manual entry of N value and array elements
2: To display time taken for sorting number of elements N in the range 500 to 14500
3: To exit
Enter your choice: 3

Process returned 0 (0x0)   execution time : 29.531 s
Press any key to continue.
```

Graph:

N Value	Time Taken
500	0
1500	0.015
2500	0.016
3500	0.016
4500	0.047
5500	0.078
6500	0.094
7500	0.124
8500	0.188
9500	0.234
10500	0.266
11500	0.312
12500	0.375
13500	0.407
14500	0.468



Floyd's Algorithm:

```
#include <stdio.h> #define
V 5
#define INF 99999
void printSolution(int dist[][V]);

void floydWarshall(int dist[][V])
{
   int i, j, k;

   /* Add all vertices one by one to
the set of intermediate vertices.       --->
Before start of an iteration, we       have
shortest distances between all       pairs of
vertices such that the shortest
distances consider only the       vertices in
set {0, 1, 2, .. k-1} as       intermediate
vertices.       ----> After the end of an
iteration,       vertex no. k is added to the
set of       intermediate vertices and the
set       becomes {0, 1, 2, .. k} */     for (k
= 0; k < V; k++) {
       // Pick all vertices as source one by one
for (i = 0; i < V; i++) {
           // Pick all vertices as destination for the
           // above picked source
for (j = 0; j < V; j++) {
               // If vertex k is on the shortest path from                // i to j, then update the value of
               // dist[i][j]               if (dist[i][k] +
dist[k][j] < dist[i][j])                   dist[i][j] =
dist[i][k] + dist[k][j];
```

```
            }
        }
    }

    printSolution(dist);
} void printSolution(int
dist[][V])
{
    printf(
        "The following matrix shows the shortest distances"
        " between every pair of vertices \n");
for (int i = 0; i < V; i++) {         for (int j =
0; j < V; j++) {             if (dist[i][j] ==
INF)                 printf("%7s", "INF");
            else
                printf("%7d", dist[i][j]);
        }
        printf("\n");
    }
} int main() {     int graph[V][V] = { { 0, 4,
INF, 5,INF },
                    { INF, 0, 1, INF,6 },
                    { 2,INF, 0, 3,INF },
                    { INF, INF, 1, 0,2 } ,
{1,INF,INF,4,0}};
    floydWarshall(graph);
    return 0;
}
```

Output:

```
The following matrix shows the shortest distances between every pair of vertices
      0      4      5      5      7
      3      0      1      4      6
      2      6      0      3      5
      3      7      1      0      2
      1      5      5      4      0

Process returned 0 (0x0)   execution time : 0.153 s
Press any key to continue.
```

LAB 9:

Knapsack using Dynamic Programming:

```
#include <stdio.h>

#define N 4
#define CAPACITY 7

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

}

void knapsack(int weights[], int profits[]) {
   int i, w;
   int dp[N + 1][CAPACITY + 1];

   for (i = 0; i <= N; i++) {
      for (w = 0; w <= CAPACITY; w++) {
```

```
        if (i == 0 || w == 0)                dp[i][w] = 0;            else if (weights[i - 1] <=
w)                dp[i][w] = max(profits[i - 1] + dp[i - 1][w - weights[i - 1]], dp[i -
1][w]);
        else
            dp[i][w] = dp[i - 1][w];
      }
   }

   int maxProfit = dp[N][CAPACITY];
printf("Maximum profit: %d\n", maxProfit);

   int selectedObjects[N];
int k = N, c = CAPACITY;
while (k > 0 && c > 0) {
      if (dp[k][c] != dp[k - 1][c]) {
selectedObjects[k - 1] = 1;            c
=c- weights[k - 1];
      } else {
selectedObjects[k - 1] = 0;
      }
k--;
   }

   printf("\nTable Values (DP Table):\n");
   for (i = 0; i <= N; i++) {
      for (w = 0; w <= CAPACITY; w++) {
         printf("%d\t", dp[i][w]);
      }
      printf("\n");
   }
```

```
   printf("\nObjects selected in the knapsack:\n");     for (i = 0; i < N; i++) {         if
(selectedObjects[i] == 1)            printf("Object %d (Weight: %d, Profit: %d)\n", i +
1, weights[i], profits[i]);
   }
}

int main() {     int
weights[N];     int
profits[N];

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

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

   printf("Knapsack Capacity: %d\n", CAPACITY);
   printf("Objects:\n");
   for (int i = 0; i < N; i++) {         printf("Object %d - Weight: %d, Profit: %d\n",
i + 1, weights[i], profits[i]);
   }
   knapsack(weights, profits);

   return 0;
}
```

Output:

```
Enter the weights:
1 3 4 5
Enter the profits:
1 4 5 7
Knapsack Capacity: 7
Objects:
Object 1 - Weight: 1, Profit: 1
Object 2 - Weight: 3, Profit: 4
Object 3 - Weight: 4, Profit: 5
Object 4 - Weight: 5, Profit: 7
Maximum profit: 9

Table Values (DP Table):
0       0       0       0       0       0       0       0
0       1       1       1       1       1       1       1
0       1       1       4       5       5       5       5
0       1       1       4       5       6       6       9
0       1       1       4       5       7       8       9

Objects selected in the knapsack:
Object 2 (Weight: 3, Profit: 4)
Object 3 (Weight: 4, Profit: 5)

Process returned 0 (0x0)   execution time : 14.113 s
Press any key to continue.
```

Prims Algorithm:

```
#include <stdio.h>
#include <limits.h> #define
MAX 100
void prims(int n, int cost[MAX][MAX], int INF) {
int S[MAX], d[MAX], p[MAX], T[MAX][2];
    int i, j, min, source, sum = 0, k = 0, u;     min
= INF;     source = 0;     for (i = 0; i < n; i++) {
for (j = 0; j < n; j++) {             if (cost[i][j] != 0
```

```
&& cost[i][j] < min) {                min =
cost[i][j];                source = i;
          }
       }
}
   for (i = 0; i < n; i++) {
S[i] = 0;         d[i] =
cost[source][i];         p[i] =
source;     }
   S[source] = 1;     for (i
= 1; i < n; i++) {
min = INF;
       u = -1;         for (j = 0; j < n; j++)
{            if (S[j] == 0 && d[j] <= min)
{
             min = d[j];
             u = j;
          }
       }
       T[k][0] = u;
T[k][1] = p[u];         k++;
       sum += cost[u][p[u]];         S[u] = 1;
for (j = 0; j < n; j++) {            if (S[j] == 0
&& cost[u][j] < d[j]) {
             d[j] = cost[u][j];
p[j] = u;
          }
       }
   }
```

```
   if (sum >= INF) {         printf("Spanning
tree does not exist.\n");
   } else {
      printf("Spanning tree exists and MST is:\n");
      for (i = 0; i < n - 1; i++) {
printf("%d -> %d\n", T[i][1], T[i][0]);
      }
      printf("The cost of Spanning tree is MST is %d\n", sum);
   }
}

int main() {     int n,
cost[MAX][MAX], i, j;     int
INF = INT_MAX;
   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]);
if (cost[i][j] == 9999 ) {                cost[i][j] =
INF;
          }
      }
   }
   prims(n, cost, INF);
return 0;
}
```
Output:

```
Enter the number of vertices: 5
Enter the cost adjacency matrix:
0 5 15 20 9999
5 0 25 9999 9999
15 25 0 30 37
20 9999 30 0 35
9999 9999 37 35 0
Spanning tree exists and MST is:
0 -> 1
0 -> 2
0 -> 3
3 -> 4
The cost of Spanning tree is MST is 75

Process returned 0 (0x0)   execution time : 48.002 s
Press any key to continue.
```

LAB 10:

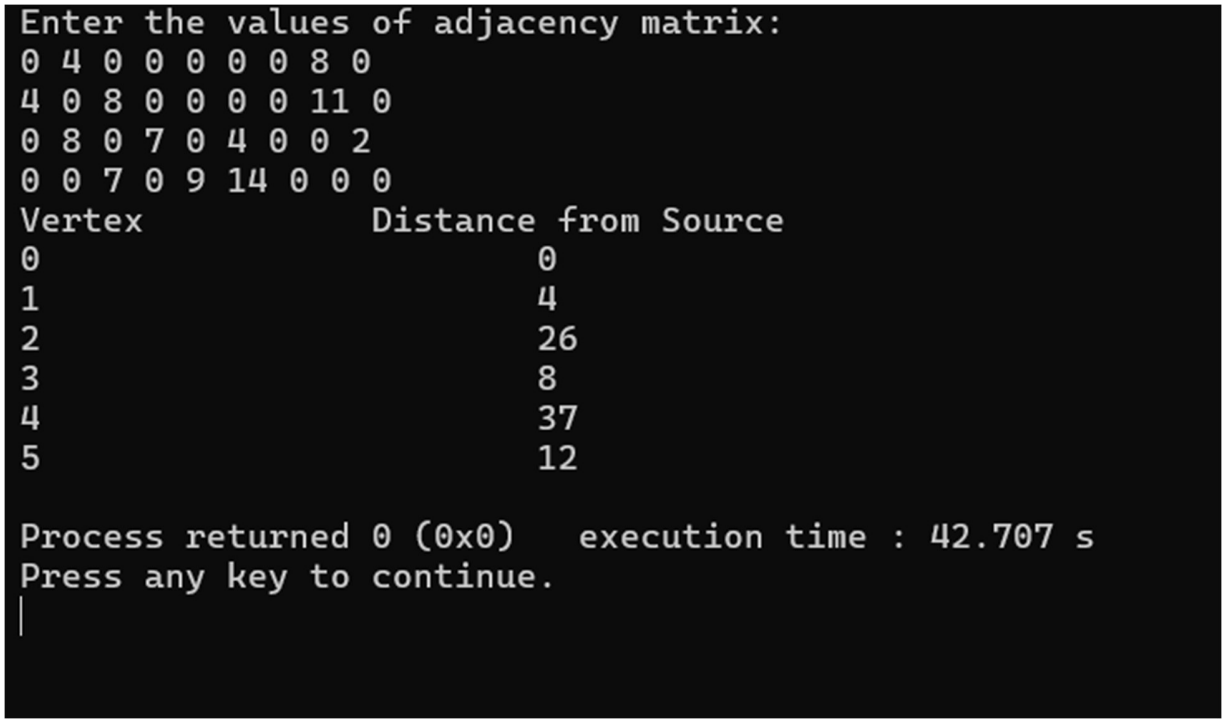
Dijkstra's Algorithm:

```
#include <limits.h>
#include <stdbool.h>
#include <stdio.h> #define V 6 int
minDistance(int dist[], bool sptSet[])
{
   int min = INT_MAX, min_index;

   for (int v = 0; v < V; v++)        if
(!sptSet[v] && dist[v] <= min) {
min = dist[v];            min_index = v;
      }

   return min_index;
```

```
void printSolution(int dist[])
{    printf("Vertex \t\t Distance from Source\n");
for (int i = 0; i < V; i++)          printf("%d \t\t\t
%d\n", i, dist[i]);
} void dijkstra(int graph[V][V], int
src)
{    int dist[V];
bool sptSet[V];
for (int i = 0; i <
V; i++)
dist[i] =
INT_MAX,
sptSet[i] = false;
   dist[src] = 0;    for (int count = 0; count < V
- 1; count++) {        int u = minDistance(dist,
sptSet);        sptSet[u] = true;

      for (int v = 0; v < V; v++)           if
(!sptSet[v] && graph[u][v]              &&
dist[u] != INT_MAX              && dist[u] +
graph[u][v] < dist[v])              dist[v] =
dist[u] + graph[u][v];
   }

   printSolution(dist);
} int main() {    int graph[V][V];    printf("Enter the
values of adjacency matrix:\n");    for (int i = 0; i <
V; i++) {              for (int j = 0; j < V; j++) {
scanf("%d", &graph[i][j]);
```

```
        }
    }

    dijkstra(graph, 0);

    return 0;
}
```

Output:



Kruskal's Algorithm:

```
#include <stdio.h> #include <stdlib.h> int
comparator(const void* p1, const void* p2)
{    const int(*x)[3] =
p1;    const int(*y)[3] =
p2;
```

```
   return (*x)[2] - (*y)[2];
} void makeSet(int parent[], int rank[], int
n)
{
   for (int i = 0; i < n; i++) {
parent[i] = i;          rank[i] =
0;
   }
} int findParent(int parent[], int
component)
{    if (parent[component] != component) {
parent[component] = findParent(parent, parent[component]);
   }
   return parent[component];
} void unionSet(int u, int v, int parent[], int
rank[])
{    u = findParent(parent,
u);    v = findParent(parent,
v);    if (rank[u] < rank[v])
{       parent[u] = v;
   } else if (rank[u] > rank[v]) {
parent[v] = u;    } else {
parent[v] = u;        rank[u]++;
   }
}

void kruskalAlgo(int n, int edges[][3], int e)
{    qsort(edges, e, sizeof(edges[0]),
comparator);    int parent[n];
```

```
   int rank[n];     makeSet(parent, rank, n);     int minCost = 0;
printf("Following are the edges in the constructed MST\n");
   for (int i = 0; i < e; i++) {         int u =
edges[i][0];         int v = edges[i][1];         int wt =
edges[i][2];         int parent_u = findParent(parent,
u);         int parent_v = findParent(parent, v);
if (parent_u != parent_v) {
unionSet(parent_u, parent_v, parent, rank);
minCost += wt;             printf("%d -- %d ==
%d\n", u, v, wt);
      }
   }
   printf("Minimum Cost Spanning Tree: %d\n", minCost);
}

int main() {
   int n, e;
   printf("Enter the number of vertices: ");
scanf("%d", &n);     printf("Enter the
number of edges: ");     scanf("%d", &e);
int edges[e][3];     printf("Enter the edges
(u v wt):\n");     for (int i = 0; i < e; i++) {
      scanf("%d %d %d", &edges[i][0], &edges[i][1], &edges[i][2]);
   }
   kruskalAlgo(n, edges, e);
   return 0;
}
```

Output:

```
Enter the number of vertices: 5
Enter the number of edges: 5
Enter the edges (u v wt):
0 1 10
0 2 6
0 3 5
1 3 15
2 3 4
Following are the edges in the constructed MST
2 -- 3 == 4
0 -- 3 == 5
0 -- 1 == 10
Minimum Cost Spanning Tree: 19

Process returned 0 (0x0)   execution time : 19.203 s
Press any key to continue.
```

Greedy knapsack Problem:

```
#include <stdio.h> void
main() {
   int n;     float m;
printf("Enter the capacity\n");
scanf("%f", &m);


   printf("Enter the number of objects\n");     scanf("%d", &n);
printf("Enter the elements of Profit/ Weight of %d objects\n", n);

   float w[n], p[n], x[n];     float
ratio[n];     for (int i = 0; i < n; i++)
{        scanf("%f %f", &p[i],
&w[i]);
       x[i] = 0;
ratio[i] = p[i] / w[i];
   }
```

```
   for (int i = 0; i < n - 1; i++) {
for (int j = 0; j < n - i - 1; j++) {
if (ratio[j] < ratio[j + 1]) {
// Swap profits                float tp =
p[j + 1];               p[j + 1] = p[j];
p[j] = tp;              // Swap weights
float tw = w[j + 1];                w[j +
1] = w[j];              w[j] = tw;
// Swap ratios                float tr =
ratio[j + 1];               ratio[j + 1] =
ratio[j];               ratio[j] = tr;
          }
      }    }    float rc = m;
float mp = 0;     for (int i =
0; i < n; i++) {
      // If weight is less than remaining capacity         if (w[i] <= rc) {          // make it visited          x[i] =
1;
          // Subtract weight from remaining capacity
          rc -= w[i];           //
Add to total Profit
mp += p[i];
      }
      // If weight is greater than capacity
      else {
          // Take portion of remaining capacity
          x[i] = rc / w[i];           // add to
profit           mp += x[i] * p[i];
break; // No more capacity left
      }
   }
```

```
    printf("The Selected objects are:\n");
for (int i = 0; i < n; i++) {
        if (x[i]) {
            printf("Object %d (fraction: %.2f)\n", i + 1, x[i]);
        }
    }
    printf("The Maximum Profit is: %.2f\n", mp);
}
```

Output:

```
Enter the capacity
40
Enter the number of objects
3
Enter the elements of Profit/ Weight of 3 objects
30 20
40 25
35 10
The Selected objects are:
Object 1 (fraction: 1.00)
Object 2 (fraction: 1.00)
Object 3 (fraction: 0.25)
The Maximum Profit is: 82.50

Process returned 29 (0x1D)   execution time : 13.050 s
Press any key to continue.
```

N Queens Problem:

```
#include <stdio.h>
#include <stdbool.h>
#define N 8  // You can change N to any number to solve for different board size void
printSolution(int board[N][N]) {
```

```
    for (int i = 0; i < N; i++) {
for (int j = 0; j < N; j++) {
printf("%2d ", board[i][j]);
        }
        printf("\n");
    }
}

bool isSafe(int board[N][N], int row, int col) {
    int i, j;

    // Check this row on the left side
for (i = 0; i < col; i++)         if
(board[row][i])             return false;

    // Check upper diagonal on the left side     for
(i = row, j = col; i >= 0 && j >= 0; i--, j--)
        if (board[i][j])
return false;

    // Check lower diagonal on the left side     for
(i = row, j = col; j >= 0 && i < N; i++, j--)
        if (board[i][j])
return false;

    return true;
}

bool solveNQUtil(int board[N][N], int col) {
```

```
   // If all queens are placed
if (col >= N)         return
true;

   // Consider this column and try placing this queen in all rows one by one
   for (int i = 0; i < N; i++) {
      // Check if the queen can be placed on board[i][col]
if (isSafe(board, i, col)) {

         // Place this queen in board[i][col]
board[i][col] = 1;

         // Recur to place the rest of the queens
if (solveNQUtil(board, col + 1))
            return true;

         // If placing queen in board[i][col] doesn't lead to a solution
         // then backtrack
         board[i][col] = 0; // Remove queen from board[i][col]
      }
   }
   // If the queen cannot be placed in any row in this column, return false
return false;

bool solveNQ() {     int
board[N][N] = {0};

   if (!solveNQUtil(board, 0)) {
printf("Solution does not exist");         return
false;
   }
```

```
    printSolution(board);
return true;
} int main() {
solveNQ();
    return 0;
}
```

Output: