# VISVESVARAYA TECHNOLOGICAL UNIVERSITY

**"JnanaSangama", Belgaum -590014, Karnataka.**

**LAB REPORT**
**on**

# Analysis and Design of Algorithms

***Submitted by***

**PRADEEP P T (1BM22CS197)**

***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**
**April-2024 to August-2024**

# 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 **PRADEEP P T (1BM22CS197),** 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.

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# Index Sheet

## 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. |

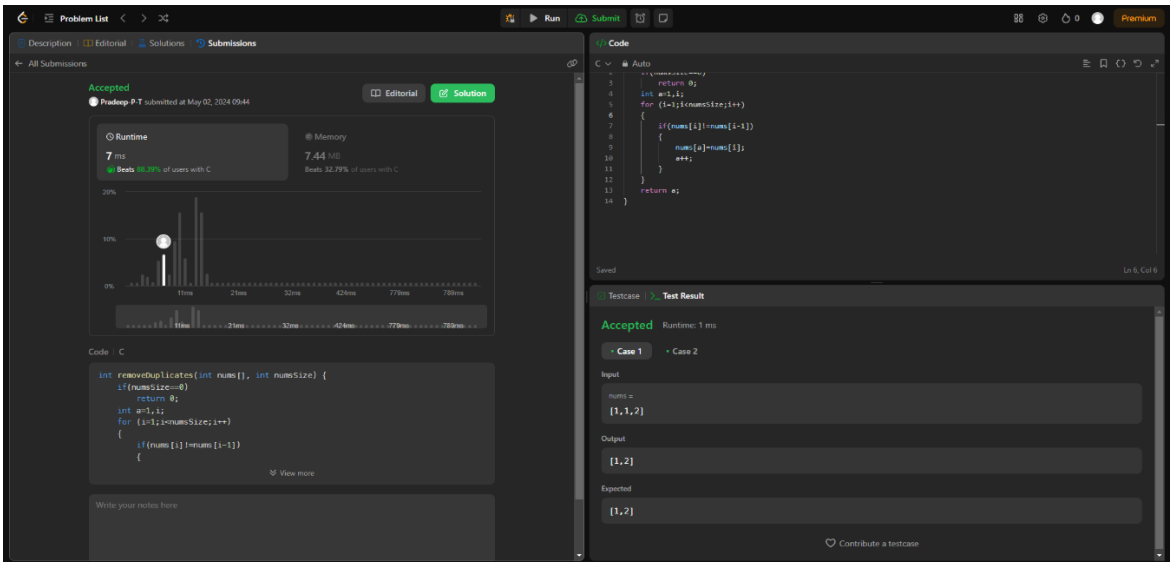
# Lab Program - 1

# Leetcode (Remove Duplicates from Sorted Array)

## Code:

```
int removeDuplicates(int nums[], int numsSize) {
    if(numsSize==0)
        return 0;
    int a=1,i;
    for (i=1;i<numsSize;i++)
    {
        if(nums[i]!=nums[i-1])
        {
            nums[a]=nums[i];
            a++;
        }
    }
    return a;
}
```

## Output:



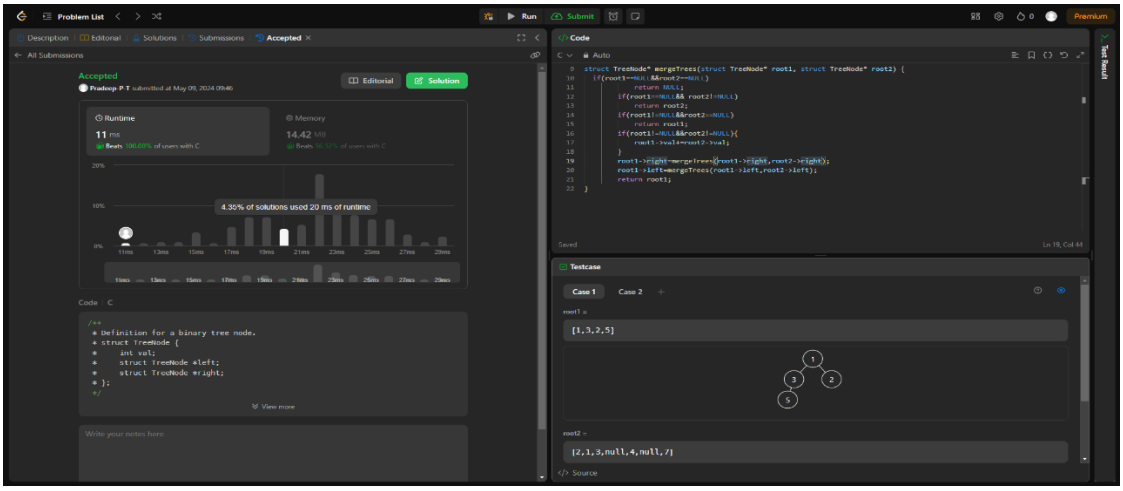
# Lab Program - 2

# Leetcode (Merge Two Binary Trees)

## Code:

```
struct TreeNode* mergeTrees(struct TreeNode* root1, struct TreeNode* root2) {
  if(root1==NULL&&root2==NULL)
        return NULL;
      if(root1==NULL&& root2!=NULL)
        return root2;
      if(root1!=NULL&&root2==NULL)
        return root1;
      if(root1!=NULL&&root2!=NULL){
        root1->val+=root2->val;
      }
      root1->right=mergeTrees(root1->right,root2->right);
      root1->left=mergeTrees(root1->left,root2->left);
      return root1;
}
```

## Output:



## Lab Program - 3

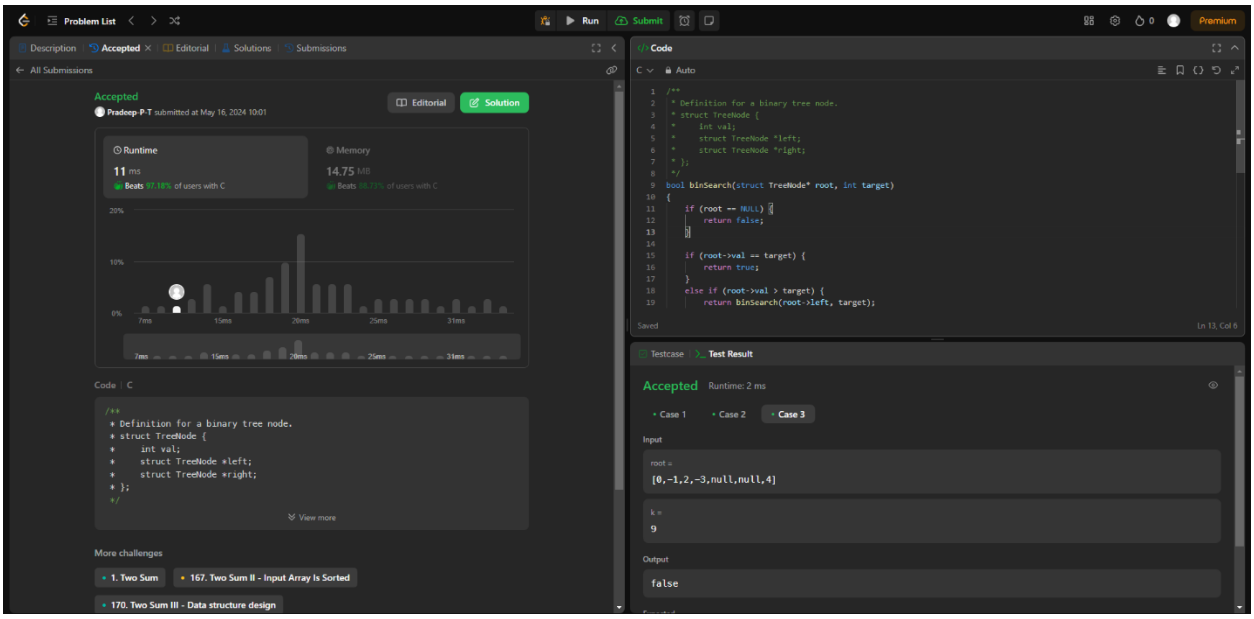
## Leetcode (Two Sum IV – Input is a BST)

### Code:

```
bool binSearch(struct TreeNode* root, int target)
{
    if (root == NULL) {
        return false;
    }

    if (root->val == target) {
        return true;
    }
    else if (root->val > target) {
        return binSearch(root->left, target);
    }
    else {
        return binSearch(root->right, target);
    }
}

bool dfs(struct TreeNode *root, struct TreeNode *curr, int target)
{
    if (curr==NULL) {
        return false;
    }
```

```
    if (target - curr->val != curr->val) {
        if (binSearch(root, target - curr->val) == true) {
            return true;
        }
    }

    return (dfs(root, curr->left, target) || dfs(root, curr->right, target));
}

bool findTarget(struct TreeNode* root, int k){
    return dfs(root, root, k);
}
```

## Output:



# Lab Program - 4

# Topological Sorting (Source Removal and DFS)

## Code:

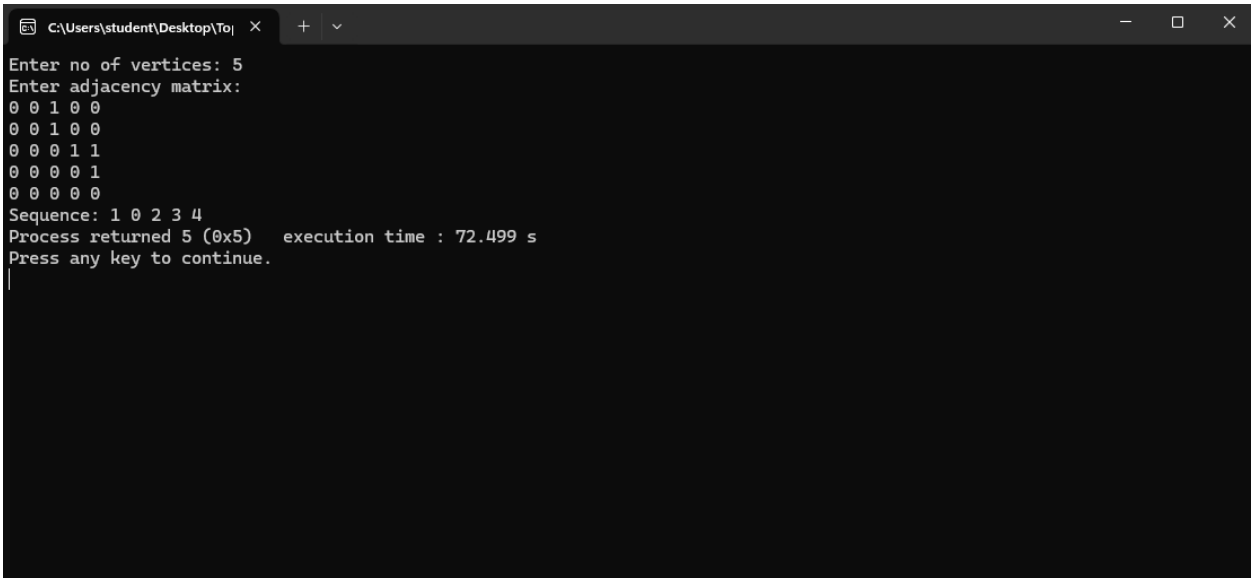
## Source Removal

```
#include<stdio.h>


void main()
{
 int n, a[30][30],i,j,sum,in[30],s[30],t[30],k=0;
 printf("Enter no of vertices: ");
 scanf("%d",&n);
 printf("Enter adjacency matrix:\n");
 for(i=0;i<n;i++)
 {
    for(j=0;j<n;j++)
    {
       scanf("%d",&a[i][j]);
    }
 }
 for(j=0;j<n;j++)
 {
    sum=0;
    for(i=0;i<n;i++)
    {
       sum+=a[i][j];
    }
```

```
    in[j]=sum;
}
int top=-1;
for(i=0;i<n;i++)
{
    if(in[i]==0)
    {
        top++;
        s[top]=i;
    }

}
while(top!=-1)
{
  int u=s[top];
  top--;
  t[k++]=u;
  for(int i=0;i<n;i++)
  {
      if(a[u][i]==1)
      {
          in[i]--;
          if(in[i]==0)
          {
              top++;
              s[top]=i;
          }
```

```
        }
    }
 }
    printf("Sequence: ");
    for(i=0;i<n;i++)
    {
        printf("%d ",t[i]);
    }
}
```

## Output:




## DFS

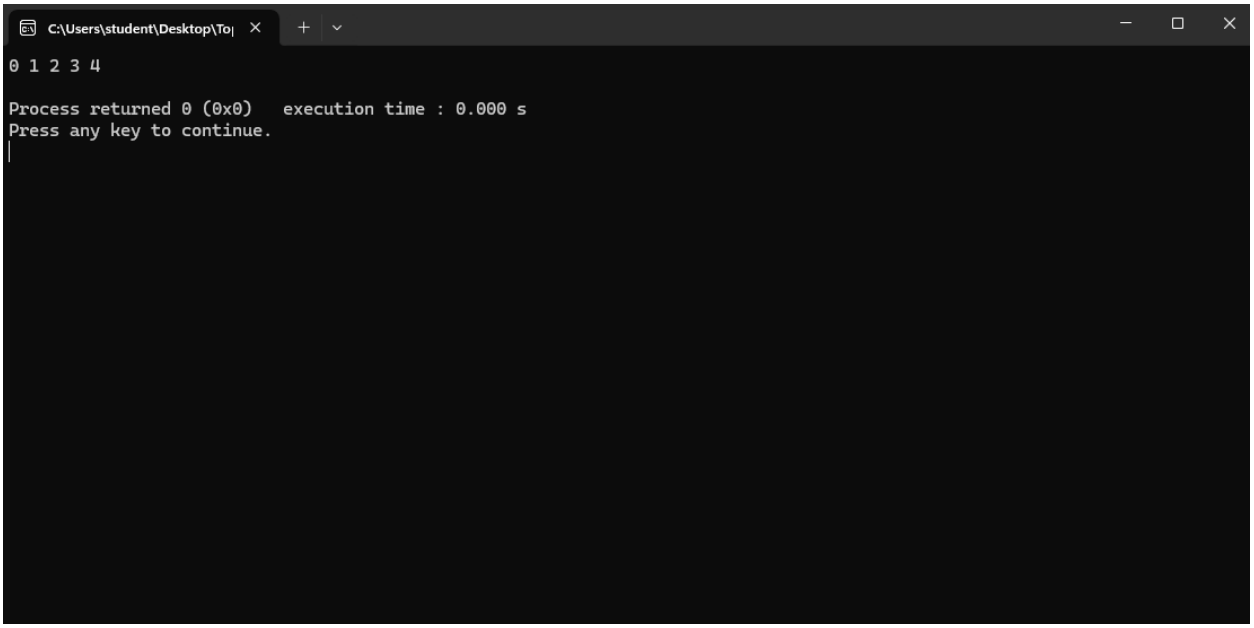
## Code:

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

void DFS(int u, int n, int a[n][n], int s[], int *j, int res[]) {
```

```
    s[u] = 1;
    for (int v = 0; v < n; v++) {
        if (a[u][v] == 1 && s[v] == 0) {
            DFS(v, n, a, s, j, res);
        }
    }
    (*j)++;
    res[*j] = u;
}

void topological_order(int n, int a[n][n]) {
    int s[n];
    for (int i = 0; i < n; i++) {
        s[i] = 0;
    }
    int j = -1;
    int res[n];

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

```
}

int main() {
    int adjacency_matrix[5][5] = {
        {0, 1, 0, 0, 0},
        {0, 0, 1, 0, 0},
        {0, 0, 0, 1, 1},
        {0, 0, 1, 0, 1},
        {0, 1, 1, 0, 0}
    };
    int num_vertices = 5;
    topological_order(num_vertices, adjacency_matrix);
    return 0;
}
```

## Output:



# Lab Program - 5

# Johnson Trotter

## Code:

```
#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
4
total permutations = 24
All possible permutations are:
 1  2  3  4
 1  2  4  3
 1  4  2  3
 4  1  2  3
 4  1  3  2
 1  4  3  2
 1  3  4  2
 1  3  2  4
 3  1  2  4
 3  1  4  2
 3  4  1  2
 4  3  1  2
 4  3  2  1
 3  4  2  1
 3  2  4  1
 3  2  1  4
 2  3  1  4
 2  3  4  1
 2  4  3  1
 4  2  3  1
 4  2  1  3
 2  4  1  3
 2  1  4  3
 2  1  3  4
```

# Substring Matching

## Code:

```
#include <string.h>

#include <stdlib.h>

#include <stdio.h>


void main(){
    char a[1000];
    char b[1000];
    printf("Enter main string: ");
```

```
    gets(a);
    printf("Enter string to search: ");
    gets(b);
    for(int i = 0; i < strlen(a) - strlen(b) + 1; i++){
        for(int j = 0; j < strlen(b); j++){
            if(a[i+j] != b[j]){
                break;
            }
            if(j == strlen(b) - 1){
                printf("String matches from position %d", i + 1);
                return;
            }
        }
    }
    printf("String doesn't match");
}
```

## Output:

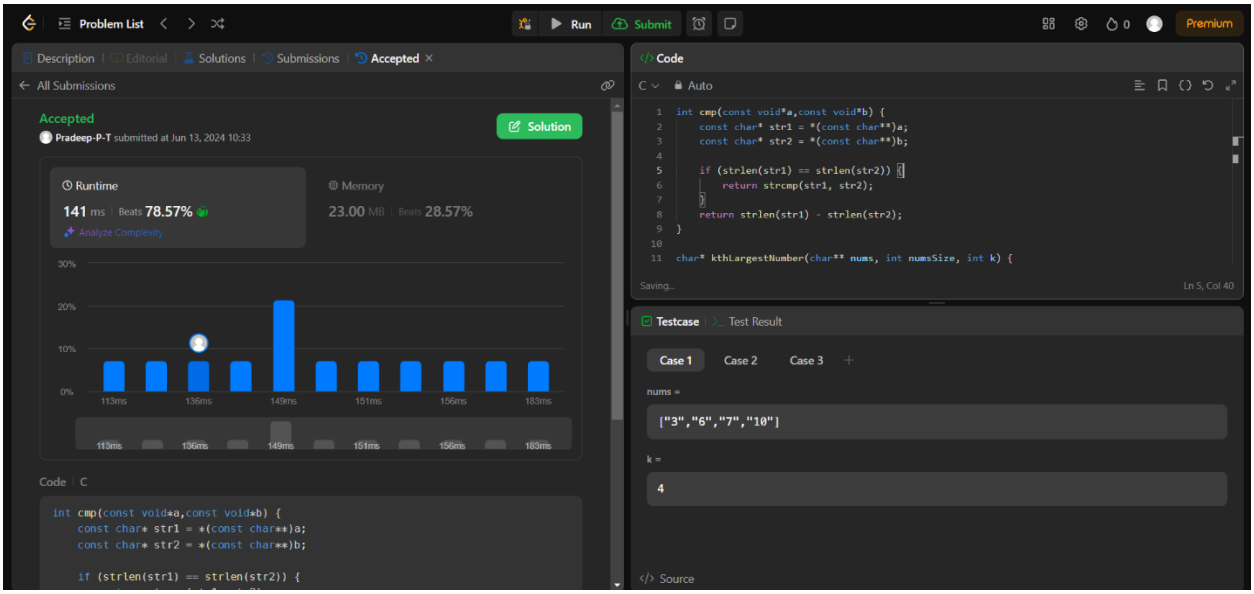
```
Enter main string: College
Enter string to search: ege
String matches from position 5
```

## Leetcode (Kth largest integer in the array)

### Code:

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

void main(){
    char a[1000];
    char b[1000];
    printf("Enter main string: ");
    gets(a);
    printf("Enter string to search: ");
    gets(b);
    for(int i = 0; i < strlen(a) - strlen(b) + 1; i++){
        for(int j = 0; j < strlen(b); j++){
            if(a[i+j] != b[j]){
                break;
            }
            if(j == strlen(b) - 1){
                printf("String matches from position %d", i + 1);
                return;
            }
        }
    }
    printf("String doesn't match");
}
```

## Output:


Problem List
Run
Submit
Premium
Description
Editorial
Solutions
Submissions
Accepted
All Submissions
Accepted
Pradeep-P-T submitted at Jun 13, 2024 10:33
Solution
Runtime
141 ms | Beats 78.57%
Analyze Complexity
Memory
23.00 MB | Beats 28.57%
30%
20%
10%
0%
113ms
136ms
149ms
151ms
156ms
183ms
Code | C
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)) {
Code
C
Auto
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) {
Saving...
Ln 5, Col 40
Testcase
Test Result
Case 1
Case 2
Case 3
nums =
["3","6","7","10"]
k =
4
Source

# Lab Program - 6

# MergeSort

## Code:

```
#include<stdio.h>
#include<time.h>
#include<stdlib.h> /* To recognise exit function when compiling with gcc*/
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)(end-
start))/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<500000;j++){ temp=38/600;}
            end=clock();
printf("\n Time taken to sort %d numbers is %f Secs",n, (((double)(end-
start))/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])
```

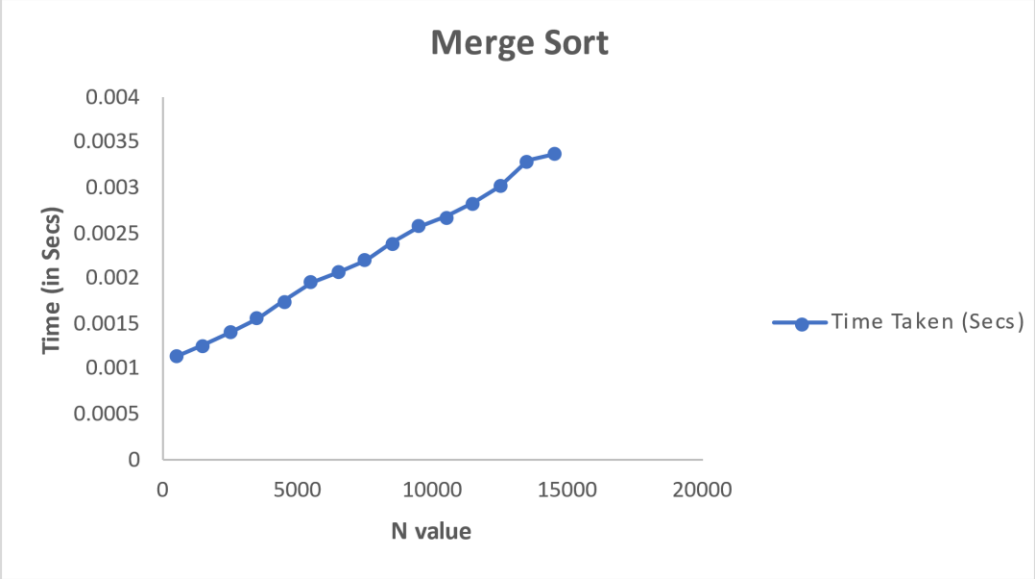
```
 {
  c[k]=a[i];
  ++k;
  ++i;
 }
 else
 {
  c[k]=a[j];
  ++k;
  ++j;
 }
}
if(i>mid)
{
 while(j<=high)
 {
  c[k]=a[j];
  ++k;
  ++j;
 }
}
if(j>high)
{
 while(i<=mid)
 {
  c[k]=a[i];
  ++k;
```

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

## Output:

```
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: 5

Enter array elements: 20 8 118 56 43

Sorted array is: 8      20      43      56      118
 Time taken to sort 5 numbers is 0.000052 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 0.001096 Secs
 Time taken to sort 1500 numbers is 0.001282 Secs
 Time taken to sort 2500 numbers is 0.001405 Secs
 Time taken to sort 3500 numbers is 0.001590 Secs
 Time taken to sort 4500 numbers is 0.001765 Secs
 Time taken to sort 5500 numbers is 0.001903 Secs
 Time taken to sort 6500 numbers is 0.002071 Secs
 Time taken to sort 7500 numbers is 0.002220 Secs
 Time taken to sort 8500 numbers is 0.002400 Secs
 Time taken to sort 9500 numbers is 0.002607 Secs
 Time taken to sort 10500 numbers is 0.002720 Secs
 Time taken to sort 11500 numbers is 0.002884 Secs
 Time taken to sort 12500 numbers is 0.003040 Secs
```

## Graph:




# SelectionSort

## Code:

```
#include<stdio.h>
#include<time.h>
#include<stdlib.h> /* To recognise exit function when compiling with gcc*/
void selsort(int n,int a[]);

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();
                    selsort(n,a);
                    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)(end-
start))/CLOCKS_PER_SEC));
                    break;
    case 2:
                n=500;
                while(n<=14500) {
                for(i=0;i<n;i++)
```

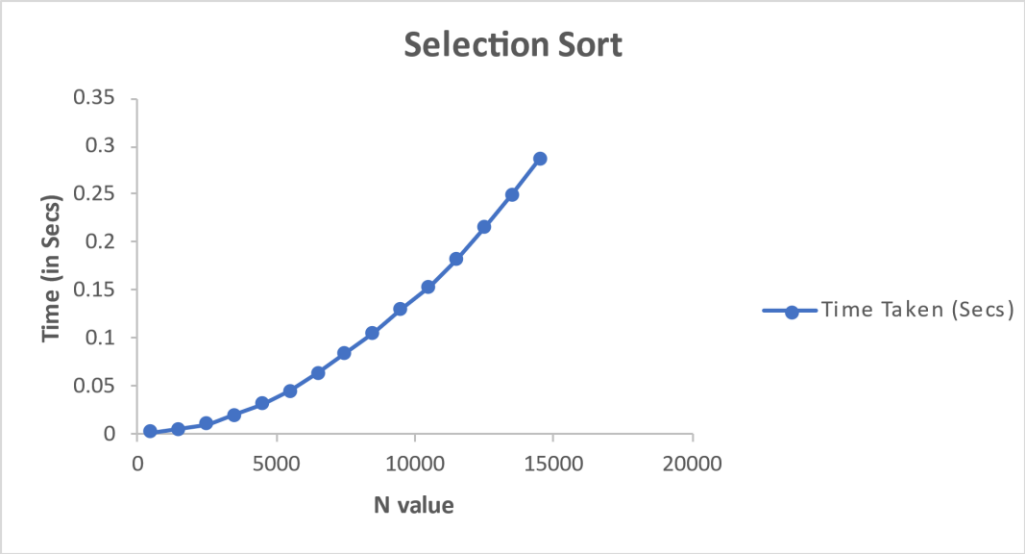
```
                    {
                     //a[i]=random(1000);
                     a[i]=n-i;
                    }
                start=clock();
                selsort(n,a);
        //Dummy loop to create delay
             for(j=0;j<500000;j++){ temp=38/600;}
            end=clock();
printf("\n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



void selsort(int n,int a[])
{
    int i,j,t,small,pos;
    for(i=0;i<n-1;i++)
     {
      pos=i;
```

```
      small=a[i];
      for(j=i+1;j<n;j++)
      {
            if(a[j]<small)
            {
              small=a[j];
              pos=j;
            }
      }
      t=a[i];
      a[i]=a[pos];
      a[pos]=t;
    }
}
```

## 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: 6

Enter array elements: 18 78 6 4 64 100

Sorted array is: 4      6       18      64      78      100
 Time taken to sort 6 numbers is 0.000002 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 0.001427 Secs
 Time taken to sort 1500 numbers is 0.004233 Secs
 Time taken to sort 2500 numbers is 0.009733 Secs
 Time taken to sort 3500 numbers is 0.017975 Secs
 Time taken to sort 4500 numbers is 0.028802 Secs
 Time taken to sort 5500 numbers is 0.042422 Secs
 Time taken to sort 6500 numbers is 0.058902 Secs
 Time taken to sort 7500 numbers is 0.078219 Secs
 Time taken to sort 8500 numbers is 0.105506 Secs
 Time taken to sort 9500 numbers is 0.132186 Secs
 Time taken to sort 10500 numbers is 0.168036 Secs
 Time taken to sort 11500 numbers is 0.198500 Secs
 Time taken to sort 12500 numbers is 0.229002 Secs
```

**Graph:**


Selection Sort
Time (in Secs)
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0
5000
10000
15000
20000
N value
Time Taken (Secs)

# Lab Program - 7

# QuickSort

## Code:

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

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

int partition(int arr[], int low, int high) {
    int pivot = arr[low];
    int i = low + 1;
    for (int j = high; j > low; j--) {
        if (arr[j] < pivot) {
            swap(&arr[i], &arr[j]);
            i++;
        }
    }
    swap(&arr[low], &arr[i - 1]);
    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);
    }
}

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]);
```

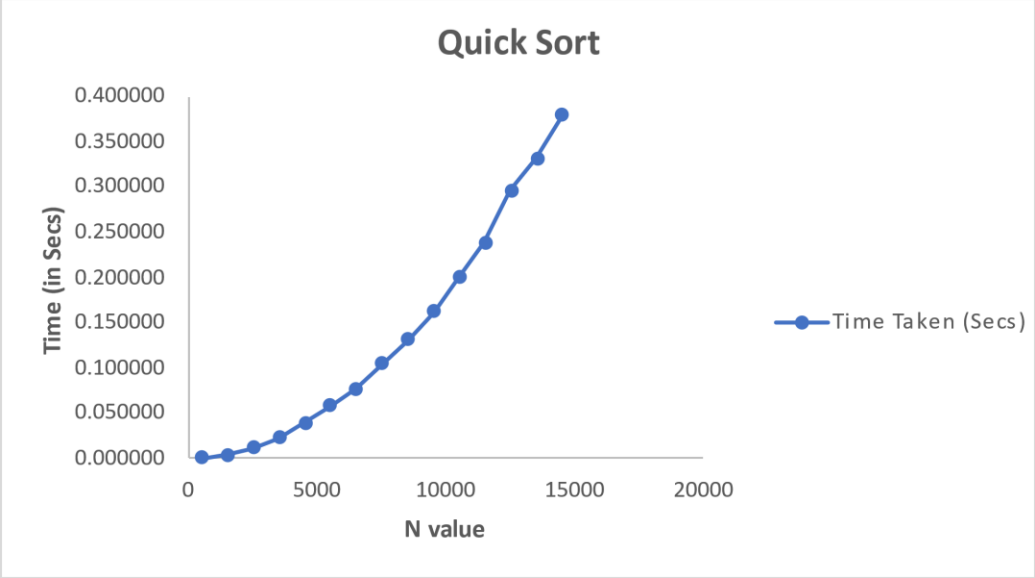
```
            }
            start=clock();
            quicksort(a,0,n-1);
            end=clock();
            printf("\nSorted array is: ");
            for(i=0;i<n;i++)
            printf("%d\t",a[i]);
            printf("\n Time taken to sort %d numbers is %f Secs",n, (((double)(end-
start))/CLOCKS_PER_SEC));
            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("\n Time 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:

```
Enter the number of elements: 5

Enter array elements: 4 1 2 3 5

Sorted array is: 1      2       3       4       5
 Time taken to sort 5 numbers is 0.000001 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 0.001701 Secs
 Time taken to sort 1500 numbers is 0.007335 Secs
 Time taken to sort 2500 numbers is 0.016030 Secs
 Time taken to sort 3500 numbers is 0.030166 Secs
 Time taken to sort 4500 numbers is 0.050065 Secs
 Time taken to sort 5500 numbers is 0.072405 Secs
 Time taken to sort 6500 numbers is 0.102483 Secs
 Time taken to sort 7500 numbers is 0.140362 Secs
 Time taken to sort 8500 numbers is 0.175819 Secs
 Time taken to sort 9500 numbers is 0.214041 Secs
 Time taken to sort 10500 numbers is 0.265348 Secs
 Time taken to sort 11500 numbers is 0.315092 Secs
 Time taken to sort 12500 numbers is 0.384209 Secs
 Time taken to sort 13500 numbers is 0.438603 Secs
 Time taken to sort 14500 numbers is 0.503937 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
```

## Graph:



# Lab Program - 8

# HeapSort

## Code:

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

void heapify(int n , int a[])
{
   int p,c,item;
   for(p=(n-1)/2;p>=0;p--)
   {
      item=a[p];
      c=2*p+1;
      while(c<=n-1)
      {
         if(c+1<=n-1)
         {
            if(a[c]<a[c+1])
               c++;
         }
            if(item<a[c])
            {
               a[p]=a[c];
               p=c;
               c=2*p+1;
            }
```

```
            else
            {
               break;
            }
        }
        a[p]=item;
    }
}

void heapsort(int n, int a[])
{
    heapify(n,a);
    for(int i=(n-1);i>0;i--)
    {
        int temp=a[0];
        a[0]=a[i];
        a[i]=temp;
        heapify(i,a);
    }
}

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

       while(1)
       {
```

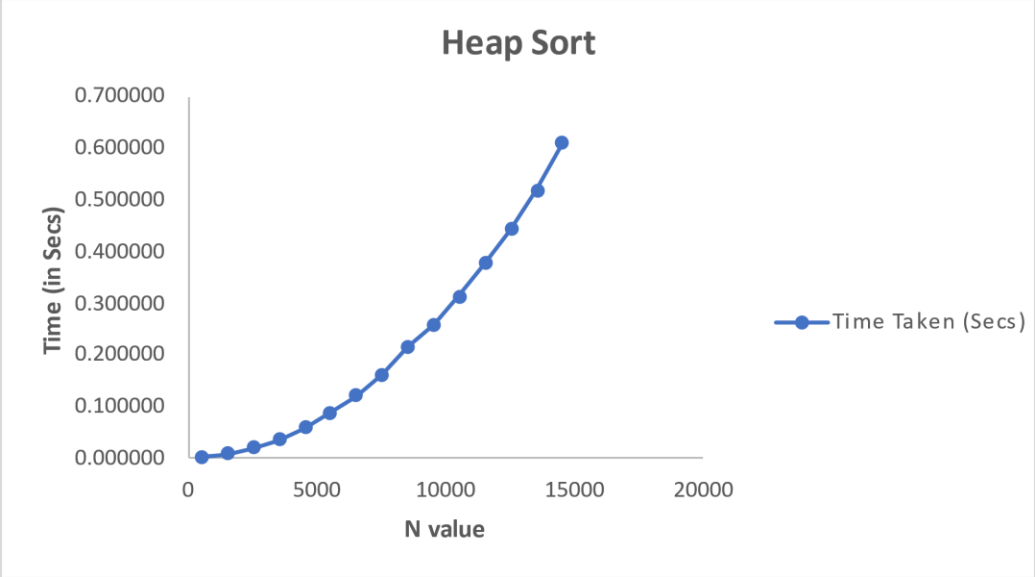
```
printf("\n1:For manual entry of N value and array elements");
printf("\n2:To display time taken for sorting number of elements N in the range 500 to 14500");
printf("\n3:To exit");
printf("\nEnter your choice:");
scanf("%d", &ch);
switch(ch)
{
  case 1:  printf("\nEnter the number of elements: ");
        scanf("%d",&n);
        printf("\nEnter array elements: ");
        for(i=0;i<n;i++)
         {
          scanf("%d",&a[i]);
         }
        start=clock();
        heapsort(n,a);
        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)(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();
        heapsort(n,a);
        for(j=0;j<500000;j++){ temp=38/600;}
        end=clock();
        printf("\n Time 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: 5

Enter array elements: 9 5 1 6 3

Sorted array is: 1      3       5       6       9
 Time taken to sort 5 numbers is 0.000002 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 0.002176 Secs
 Time taken to sort 1500 numbers is 0.010551 Secs
 Time taken to sort 2500 numbers is 0.028930 Secs
 Time taken to sort 3500 numbers is 0.057662 Secs
 Time taken to sort 4500 numbers is 0.091070 Secs
 Time taken to sort 5500 numbers is 0.126118 Secs
 Time taken to sort 6500 numbers is 0.173874 Secs
 Time taken to sort 7500 numbers is 0.235562 Secs
 Time taken to sort 8500 numbers is 0.286235 Secs
 Time taken to sort 9500 numbers is 0.375800 Secs
 Time taken to sort 10500 numbers is 0.443151 Secs
 Time taken to sort 11500 numbers is 0.539377 Secs
 Time taken to sort 12500 numbers is 0.651570 Secs
 Time taken to sort 13500 numbers is 0.864491 Secs
 Time taken to sort 14500 numbers is 0.861665 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:
```

**Graph:**


Heap Sort
0.700000
0.600000
0.500000
0.400000
0.300000
0.200000
0.100000
0.000000
Time (in Secs)
0
5000
10000
15000
20000
N value
Time Taken (Secs)

# Lab Program - 9

# Knapsack

## Code:

```
#include<stdio.h>
int max(int a, int b)
{
    return (a > b)? a : b;
}
int knapSack(int W, int wt[], int val[], int n)
{
   int i, w;
   int K[n+1][W+1];
   for(i=0;i<=n;i++)
   {
      for(w=0;w<=W;w++)
      {
         if(i==0||w==0)
            K[i][w]=0;
         else if(wt[i-1]<=w)
               K[i][w]=max(val[i-1] + K[i-1][w-wt[i-1]],K[i-1][w]);
         else
               K[i][w]=K[i-1][w];
      }
   }
   return K[n][W];
}
```

```
int main()
{
   int i, n, val[20], wt[20], W;
   printf("Enter number of items:");
   scanf("%d",&n);
   printf("Enter value and weight of items:\n");
   for(i=0;i<n;++i)
   {
   scanf("%d%d",&val[i],&wt[i]);
   }
   printf("Enter size of knapsack:");
   scanf("%d",&W);
   printf("%d",knapSack(W, wt, val, n));
   return 0;
}
```

## Output:

```
Enter number of weights: 4
Enter weights: 2 1 3 2
Enter coins in weights: 12 10 20 15
Enter the capacity of knapsack: 5
-       -       0       0       0       0       0       0       0
2       12      1       0       0       12      12      12      12
1       10      2       0       10      12      22      22      22
3       20      3       0       10      12      22      30      32
2       15      4       0       10      15      25      30      37
Maximum possible: 37
```

# Lab Program - 10

# Floyd's Algorithm

## Code:

```
#include <stdio.h>
#include <stdlib.h>
int cost[1000][1000];
void floyd(int n){
   int d[n][n];
   for(int i = 0; i < n; i++){
      for(int j = 0; j < n; j++){
         d[i][j] = cost[i][j];
      }
   }
   for(int k = 0; k < n; k++){
      for(int i = 0; i < n; i++){
         for(int j = 0; j < n; j++){
            if(d[i][j] > d[i][k] + d[k][j]){
               d[i][j] = d[i][k] + d[k][j];
            }
         }
      }
   }
   printf("Output: \n");
   for(int i = 0; i < n; i++){
      for(int j = 0; j < n; j++){
         printf("%d ", d[i][j]);
```

```
        }
        printf("\n");
    }
}
int main(){
    int n;
    printf("Enter number of elements: ");
    scanf("%d", &n);
    printf("Enter elements: \n");
    for(int i = 0; i < n; i++){
        for(int j = 0; j < n; j++){
            scanf("%d", &cost[i][j]);
        }
    }
    floyd(n);
    return 0;
}
```

## Output:

```
Enter number of elements: 4
Enter elements:
0 999 3 999
2 0 999 999
999 7 0 1
6 999 999 0
Output:
0 10 3 4
2 0 5 6
7 7 0 1
6 16 9 0

Process returned 0 (0x0)   execution time : 30.142 s
Press any key to continue.
```

# Lab Program - 11

# Prim's Algorithm

## Code:

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

void main(){
    printf("Enter number of vertices: ");
    int n;
    scanf("%d", &n);
    int cost[n][n];
    printf("Enter cost adjacency matrix: ");
    for(int i = 0; i < n; i++){
        for(int j = 0; j < n; j++){
            scanf("%d", &cost[i][j]);
        }
    }
    int min = INT_MAX, source = 0;
    for(int i = 0; i < n; i++){
        for(int j = 0; j < n; j++){
            if(cost[i][j] != 0 && cost[i][j] < min){
                min = cost[i][j];
                source = i;
            }
        }
```

```
}
int s[n], d[n], p[n];
for(int i = 0; i < n; i++){
    s[i] = 0;
    d[i] = cost[source][i];
    p[i] = source;
}
s[source] = 1;
int sum = 0, k = 0, t[n][2];
for(int i = 0; i < n; i++){
    min = INT_MAX;
    int u = -1;
    for(int j = 0; j < n; j++){
        if(s[j] == 0 && d[j] <= min){
            min = d[j];
            u = j;
        }
    }
    if (u == -1) break;

    t[k][0] = u;
    t[k][1] = p[u];
    k++;
    sum += cost[u][p[u]];
    s[u] = 1;
    for(int j = 0; j < n; j++){
        if(s[j] == 0 && cost[u][j] < d[j]){
```

```
            d[j] = cost[u][j];
            p[j] = u;
        }
    }
  }
  if(sum >= INT_MAX){
    printf("Spanning tree does not exist");
  }
  else{
    printf("MST is:\n");
    for(int i = 0; i < k; i++){
      printf("(%d, %d) ", t[i][0] + 1, t[i][1] + 1);
    }
    printf("\nThe cost of MST is %d", sum);
  }
}
```

## Output:

```
Enter number of vertices: 5
Enter 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
MST is:
(2, 1) (3, 1) (4, 1) (5, 4)
The cost of MST is 75
```

## Kruskal's Algorithm

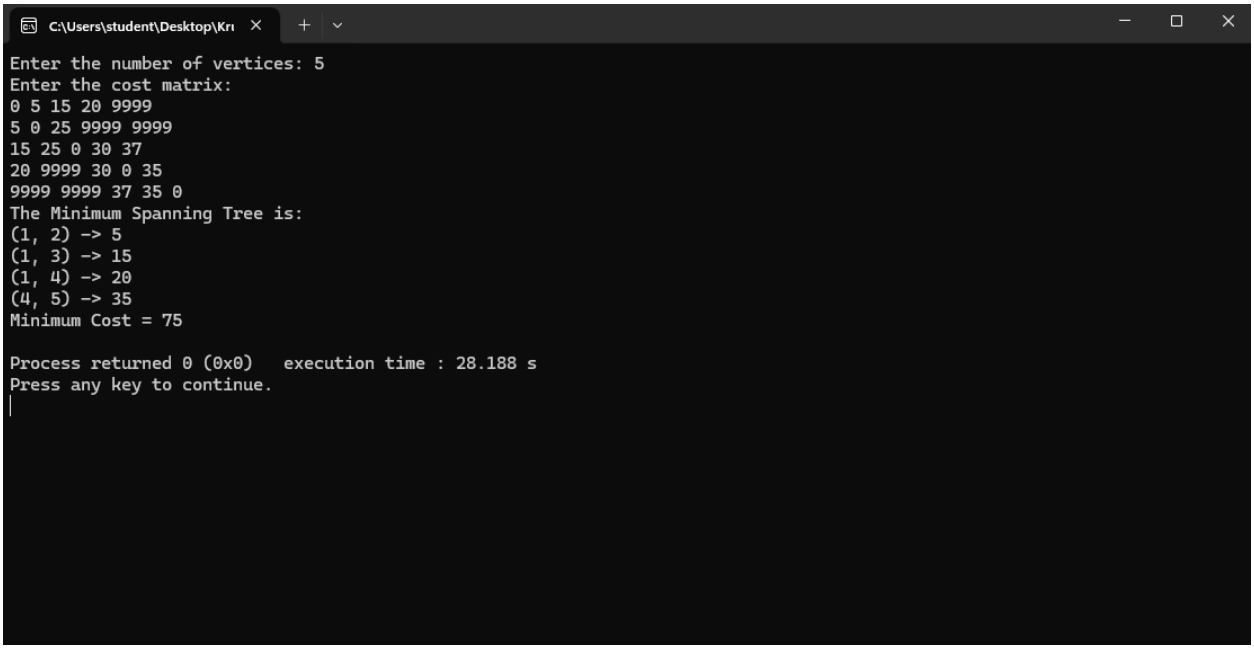
## Code:

```
#include <stdio.h>
#define MAX 30

typedef struct edge {
   int u, v, cost;
} Edge;

Edge edges[MAX];
int parent[MAX];

int find(int i) {
   while (parent[i])
      i = parent[i];
   return i;
}

int uni(int i, int j) {
   if (i != j) {
      parent[j] = i;
      return 1;
   }
   return 0;
}

void kruskals(int c[MAX][MAX], int n) {
   int i, j, u, v, a, b, min, ne = 0, mincost = 0;
```

```
    for (i = 1; i <= n; i++)
        parent[i] = 0;

    while (ne < n - 1) {
        min = 9999;
        for (i = 1; i <= n; i++) {
            for (j = 1; j <= n; j++) {
                if (c[i][j] < min) {
                    min = c[i][j];
                    u = a = i;
                    v = b = j;
                }
            }
        }

        u = find(u);
        v = find(v);

        if (uni(u, v)) {
            printf("(%d, %d) -> %d\n", a, b, min);
            mincost += min;
            ne++;
        }

        c[a][b] = c[b][a] = 9999; // Mark as visited
    }
    printf("Minimum Cost = %d\n", mincost);
}
```

```
int main() {
    int c[MAX][MAX], n, i, j;
    printf("Enter the number of vertices: ");
    scanf("%d", &n);
    printf("Enter the cost matrix:\n");
    for (i = 1; i <= n; i++) {
        for (j = 1; j <= n; j++) {
            scanf("%d", &c[i][j]);
            if (c[i][j] == 0)
                c[i][j] = 9999; // 9999 represents infinity (no edge)
        }
    }
    printf("The Minimum Spanning Tree is:\n");
    kruskals(c, n);
    return 0;
}
```

## Output:



## Lab Program - 12

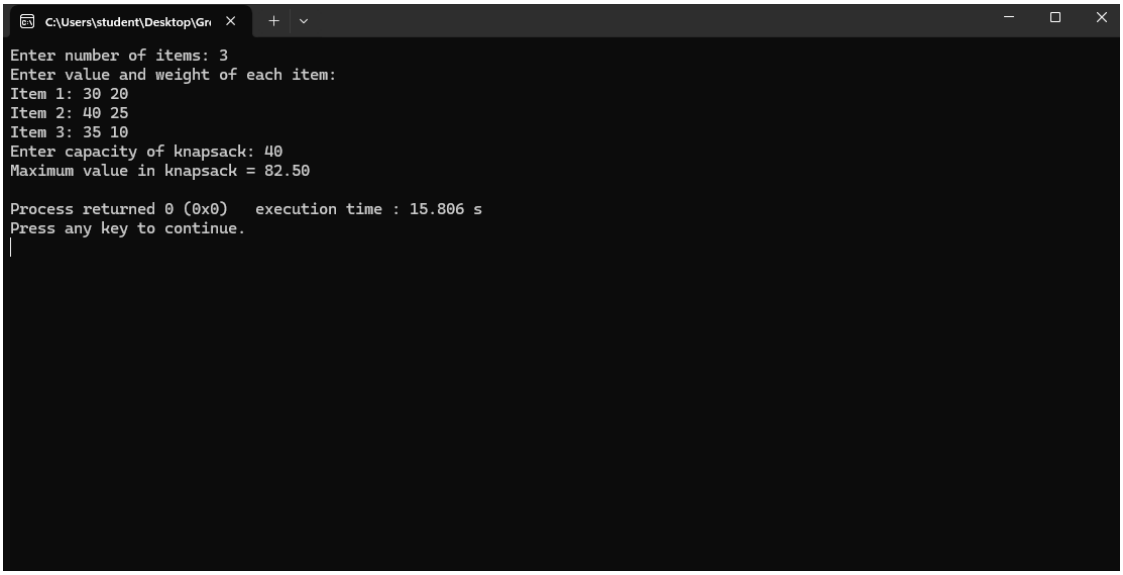
## Fractional Knapsack using Greedy technique

### Code:

```
#include <stdio.h>
#include <stdlib.h>
struct Item {
    int value;
    int weight;
};
int compare(const void *a, const void *b) {
    double ratio1 = (double)(((struct Item *)a)->value) / (((struct Item *)a)->weight);
    double ratio2 = (double)(((struct Item *)b)->value) / (((struct Item *)b)->weight);
    return (ratio2 > ratio1) - (ratio2 < ratio1);
}
int main() {
    int n;
    printf("Enter number of items: ");
    scanf("%d", &n);
    struct Item items[n];
    printf("Enter value and weight of each item:\n");
    for (int i = 0; i < n; i++) {
        printf("Item %d: ", i + 1);
        scanf("%d %d", &items[i].value, &items[i].weight);
    }
    int W;
    printf("Enter capacity of knapsack: ");
    scanf("%d", &W);
```

```
    qsort(items, n, sizeof(items[0]), compare);
    int currentWeight = 0;
    double finalValue = 0.0;
    for (int i = 0; i < n; i++) {
        if (currentWeight + items[i].weight <= W) {
            currentWeight += items[i].weight;
            finalValue += items[i].value;
        } else {
            int remainingWeight = W - currentWeight;
            finalValue += items[i].value * ((double)remainingWeight / items[i].weight);
            break;
        }
    }
    printf("Maximum value in knapsack = %.2f\n", finalValue);
    return 0;
}
```

## Output:



# Lab Program - 13

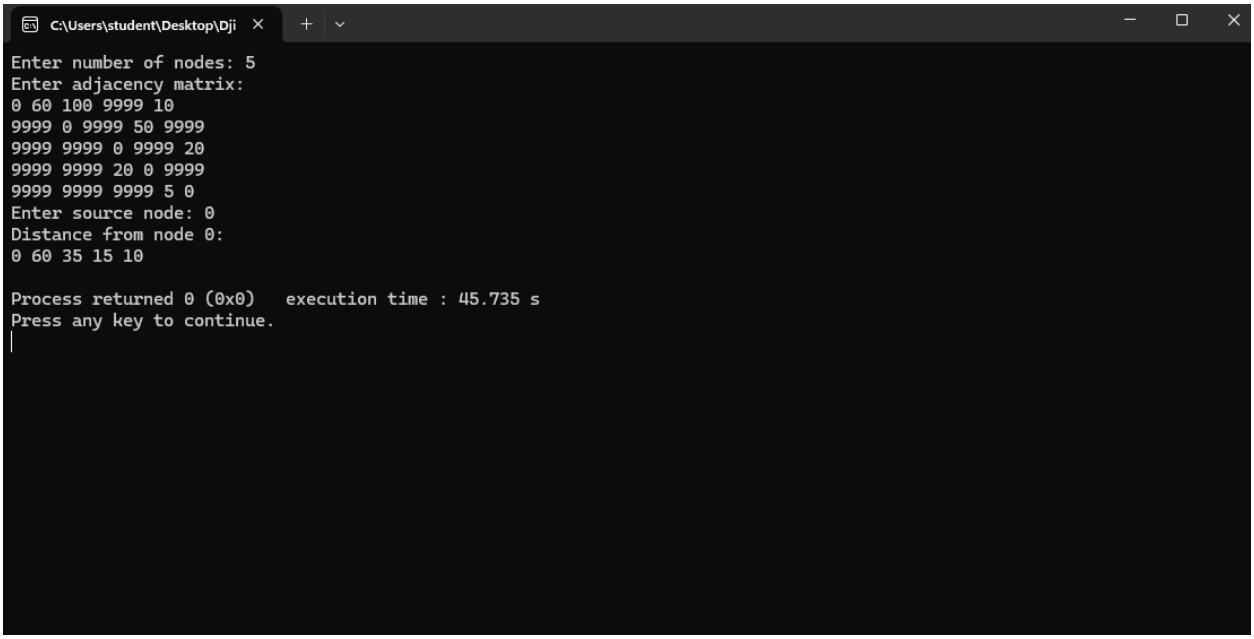
# Dijkstras Algorithm

## Code:

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

int main() {
    printf("Enter number of nodes: ");
    int n;
    scanf("%d", &n);
    int g[n][n];
    printf("Enter adjacency matrix:\n");
    for (int i = 0; i < n; i++) {
        for (int j = 0; j < n; j++) {
            scanf("%d", &g[i][j]);
        }
    }
    int s;
    printf("Enter source node: ");
    scanf("%d", &s);
    int d[n];
    int v[n];
    for (int i = 0; i < n; i++) {
        d[i] = INT_MAX;
        v[i] = 0;
    }
    d[s] = 0;
```

```
    for (int count = 0; count < n - 1; count++) {
        int u = -1;
        for (int i = 0; i < n; i++) {
            if (!v[i] && (u == -1 || d[i] < d[u])) {
                u = i;
            }
        }
        if (d[u] == INT_MAX) break;
        v[u] = 1;
        for (int i = 0; i < n; i++) {
            if (g[u][i] && !v[i] && d[u] != INT_MAX && d[u] + g[u][i] < d[i]) {
                d[i] = d[u] + g[u][i];
            }
        }
    }
    printf("Distance from node %d:\n", s);
    for (int i = 0; i < n; i++) {
        if (d[i] == INT_MAX) {
            printf("INF ");
        } else {
            printf("%d ", d[i]);
        }
    }
    printf("\n");
    return 0;
}
```

## Output:


C:\Users\student\Desktop\Dji
Enter number of nodes: 5
Enter adjacency matrix:
0 60 100 9999 10
9999 0 9999 50 9999
9999 9999 0 9999 20
9999 9999 20 0 9999
9999 9999 9999 5 0
Enter source node: 0
Distance from node 0:
0 60 35 15 10
Process returned 0 (0x0) execution time : 45.735 s
Press any key to continue.

## Lab Program - 14

## NQueens Problem using Backtracking

### Code:

```
#define N 4
#include <stdbool.h>
#include <stdio.h>

void printSolution(int board[N][N])
{
	for (int i = 0; i < N; i++) {
		for (int j = 0; j < N; j++) {
			if(board[i][j])
				printf("Q ");
			else
				printf(". ");
		}
		printf("\n");
	}
}

bool isSafe(int board[N][N], int row, int col)
{
	int i, j;
	for (i = 0; i < col; i++)
		if (board[row][i])
			return false;
	for (i = row, j = col; i >= 0 && j >= 0; i--, j--)
```

```
            if (board[i][j])
                return false;
        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 (col >= N)
            return true;

        for (int i = 0; i < N; i++) {
            if (isSafe(board, i, col)) {
                board[i][col] = 1;
                if (solveNQUtil(board, col + 1))
                    return true;
                board[i][col] = 0;
            }
        }
        return false;
}

bool solveNQ()
```

```
{
        int board[N][N] = { { 0, 0, 0, 0 },
                            { 0, 0, 0, 0 },
                            { 0, 0, 0, 0 },
                            { 0, 0, 0, 0 } };

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

        printSolution(board);
        return true;
}

int main()
{
        solveNQ();
        return 0;
}
```

## Output:

```
C:\Users\Hp\Desktop\IV SEM\LABScd "c:\Users\Hp\Desktop\IV SEM\LABS\ADA\" && gcc NQueens.c -o NQueens && "c:\Users\Hp\Desktop\IV SEM\LABS\ADA\"NQueens
. . Q .
Q . . .
. . . Q
. Q . .
```