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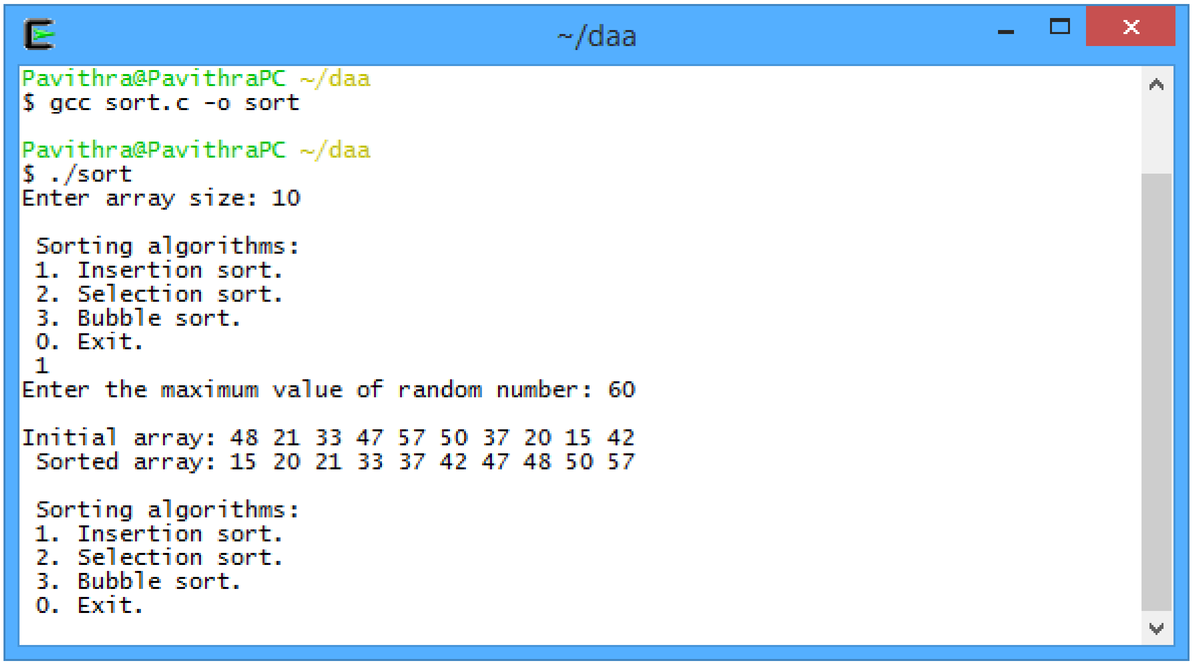
1,2,3. Insertion sort, Bubble sort and Selection sort.

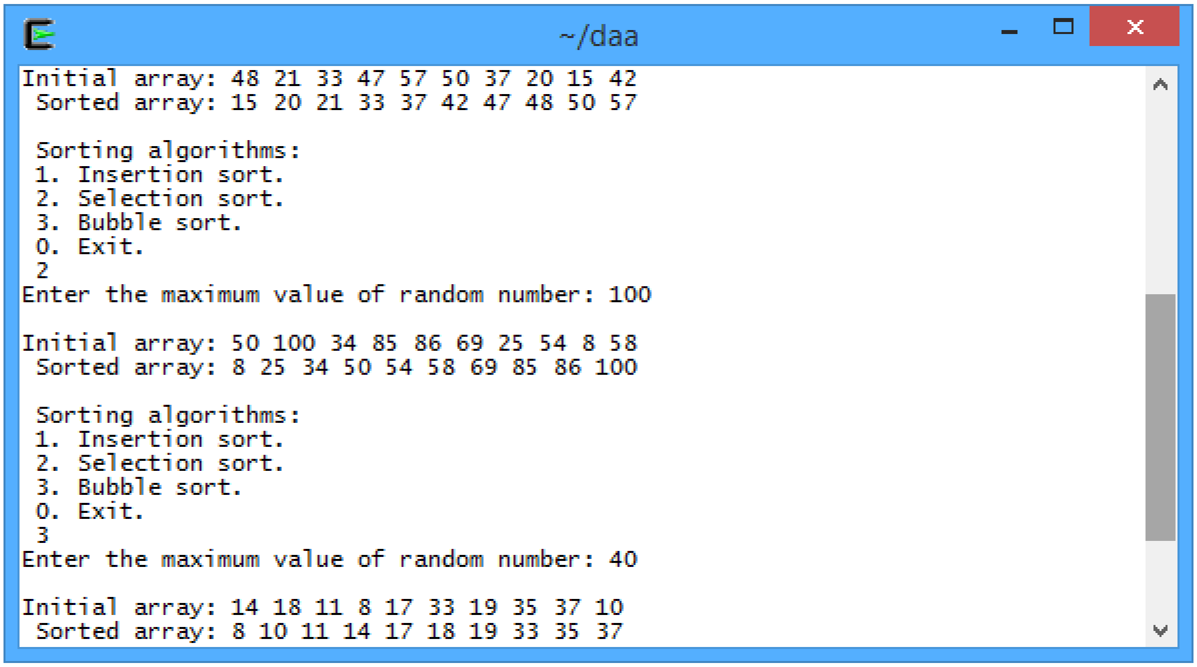
```
/*WAP to implement Insertion sort, Bubble sort and Insertion sort*/
#include<stdio.h>
#include<math.h>
#include<stdlib.h>
//Swap two numbers
void swap(int *num1,int *num2)
{
	int temp;
	temp=*num1;
	*num1=*num2;
	*num2=temp;
}
//Initialize array
void initializeArray(int *arr,int size)
{
	int i,max,num;
	printf("Enter the maximum value of random number: ");
	scanf("%d",&max);
	srand(time(NULL));
	for ( i = 0 ; i <size ; i++ )
	{
		num = rand()%max+1;
		arr[i]=num;
	}

}
//Print an array
void printArray(int *arr,int size)
{
	int i;
	for(i=0; i<size;i++)
	{
		printf("%d ",arr[i]);
	}
}
//Implementation of insertion sort
void insertionSort(int *arr,int size)
{
	int i,j;
	for(i=1;i<size;i++)
	{
		j=i;
		while(j>0 && arr[j]<arr[j-1])
		{
			swap(&arr[j],&arr[j-1]);
			j--;
		}
	}
}
//Implementation of bubble sort
void bubbleSort(int *arr,int size)
{
	int i,j;
```

```
       for(i=1;i< size;i++)
    {
         for(j=0;j< size-1;j++)
              {
                    if(arr[j]>arr[j+1])
            {
               swap(&arr[j],&arr[j+1]);
            }
             }
       }
}
//Implementation of selection sort
void selectionSort(int *arr,int size)
{
       int i,minimum,j;
       for(i=0; i<size; i++)
       {
             minimum=i;
             for(j=i;j<size;j++)
             {
                    if(arr[minimum]>arr[j])
                    {
                          minimum=j;
                    }
             }
             swap(&arr[i],&arr[minimum]);
       }
}

void main()
{
       int *arr;
       int max,i,num,noOfElements,choice;
       printf("Enter array size: ");
       scanf("%d",&noOfElements);
       arr=(int *)malloc(noOfElements*sizeof(int));

       do
       {
             printf("\n Sorting algorithms: ");
             printf("\n 1. Insertion sort. ");
             printf("\n 2. Selection sort. ");
             printf("\n 3. Bubble sort. ");
             printf("\n 0. Exit.\n ");
             scanf("%d",&choice);
             switch(choice)
             {
                    case 1:      initializeArray(arr,noOfElements);
                                 printf("\nInitial array: ");
                                 printArray(arr,noOfElements);
                                 insertionSort(arr,noOfElements);
                                 printf("\n Sorted array: ");
                                 printArray(arr,noOfElements);
                                 printf("\n");
                                 break;
                    case 2:      initializeArray(arr,noOfElements);
                                 printf("\nInitial array: ");
                                 printArray(arr,noOfElements);
                                 selectionSort(arr,noOfElements);
                                 printf("\n Sorted array: ");
                                 printArray(arr,noOfElements);
                                 printf("\n");
                                 break;
                    case 3:      initializeArray(arr,noOfElements);
                                 printf("\nInitial array: ");
                                 printArray(arr,noOfElements);
                                 bubbleSort(arr,noOfElements);
                                 printf("\n Sorted array: ");
                                 printArray(arr,noOfElements);
                                 printf("\n");
                                 break;
                    case 0: printf("\n Exiting");
                                 break;
                    default:
                                 break;
              }

       }while(choice!=0 && choice <=3);


}
```

OUTPUT


~/daa

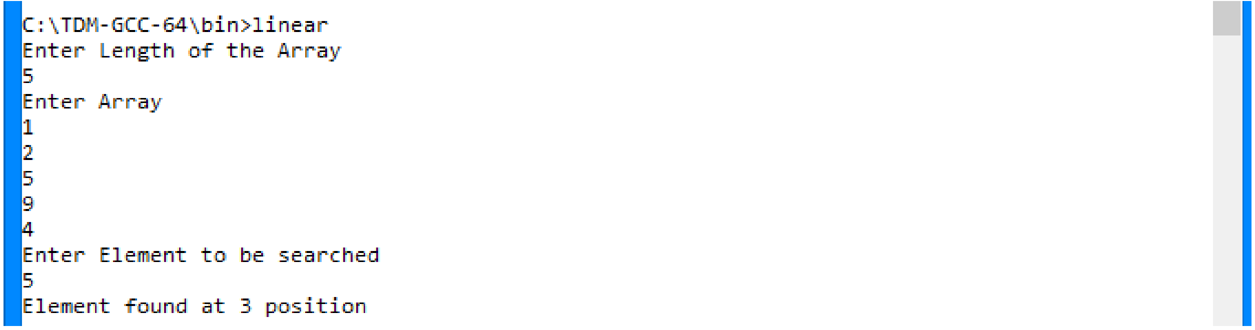
```
Pavithra@PavithraPC ~/daa
$ gcc sort.c -o sort

Pavithra@PavithraPC ~/daa
$ ./sort
Enter array size: 10

 Sorting algorithms:
 1. Insertion sort.
 2. Selection sort.
 3. Bubble sort.
 0. Exit.
 1
Enter the maximum value of random number: 60

Initial array: 48 21 33 47 57 50 37 20 15 42
 Sorted array: 15 20 21 33 37 42 47 48 50 57

 Sorting algorithms:
 1. Insertion sort.
 2. Selection sort.
 3. Bubble sort.
 0. Exit.
```


~/daa

```
Initial array: 48 21 33 47 57 50 37 20 15 42
 Sorted array: 15 20 21 33 37 42 47 48 50 57

 Sorting algorithms:
 1. Insertion sort.
 2. Selection sort.
 3. Bubble sort.
 0. Exit.
 2
Enter the maximum value of random number: 100

Initial array: 50 100 34 85 86 69 25 54 8 58
 Sorted array: 8 25 34 50 54 58 69 85 86 100

 Sorting algorithms:
 1. Insertion sort.
 2. Selection sort.
 3. Bubble sort.
 0. Exit.
 3
Enter the maximum value of random number: 40

Initial array: 14 18 11 8 17 33 19 35 37 10
 Sorted array: 8 10 11 14 17 18 19 33 35 37
```

4. Linear search

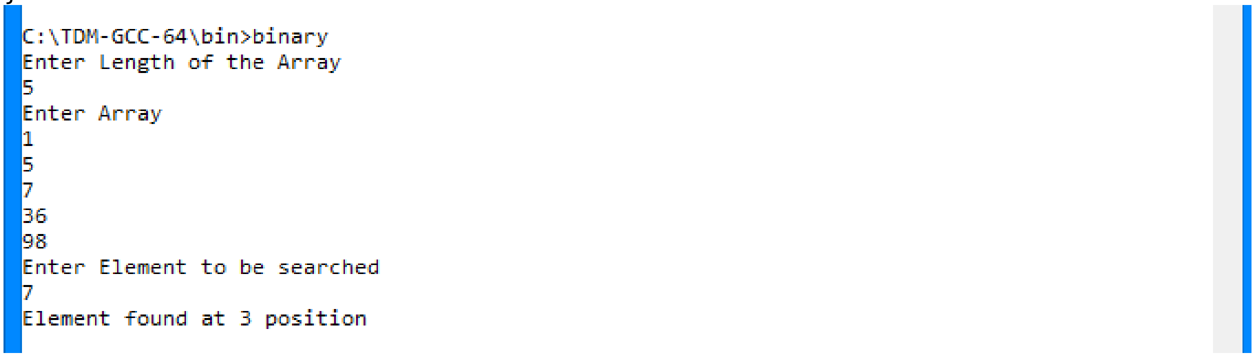
```
#include<stdio.h>
#define MAX 10

int Linear(int arr[],int n,int key)
{
 int i,pos=-1, j;
 for(i=0;i<n;i++)
 {
   if(arr[i]==key)
   {
       pos=i;
   }
 }
 return pos;
}
int main(void)
{
 int arr[MAX], n,i,key,pos;
 printf("Enter Length of the Array\n");
 scanf("%d",&n);
 printf("Enter Array \n");
 for(i=0;i<n;i++)
  scanf("%d",&arr[i]);
 printf("Enter Element to be searched\n");
 scanf("%d",&key);
 pos=Linear(arr,n,key);
 if(pos==-1)
      printf("Element not present in the list\n");
 else
      printf("Element found at %d position\n",pos+1);
}
```



```
C:\TDM-GCC-64\bin>linear
Enter Length of the Array
5
Enter Array
1
2
5
9
4
Enter Element to be searched
5
Element found at 3 position
```

5. Binary search

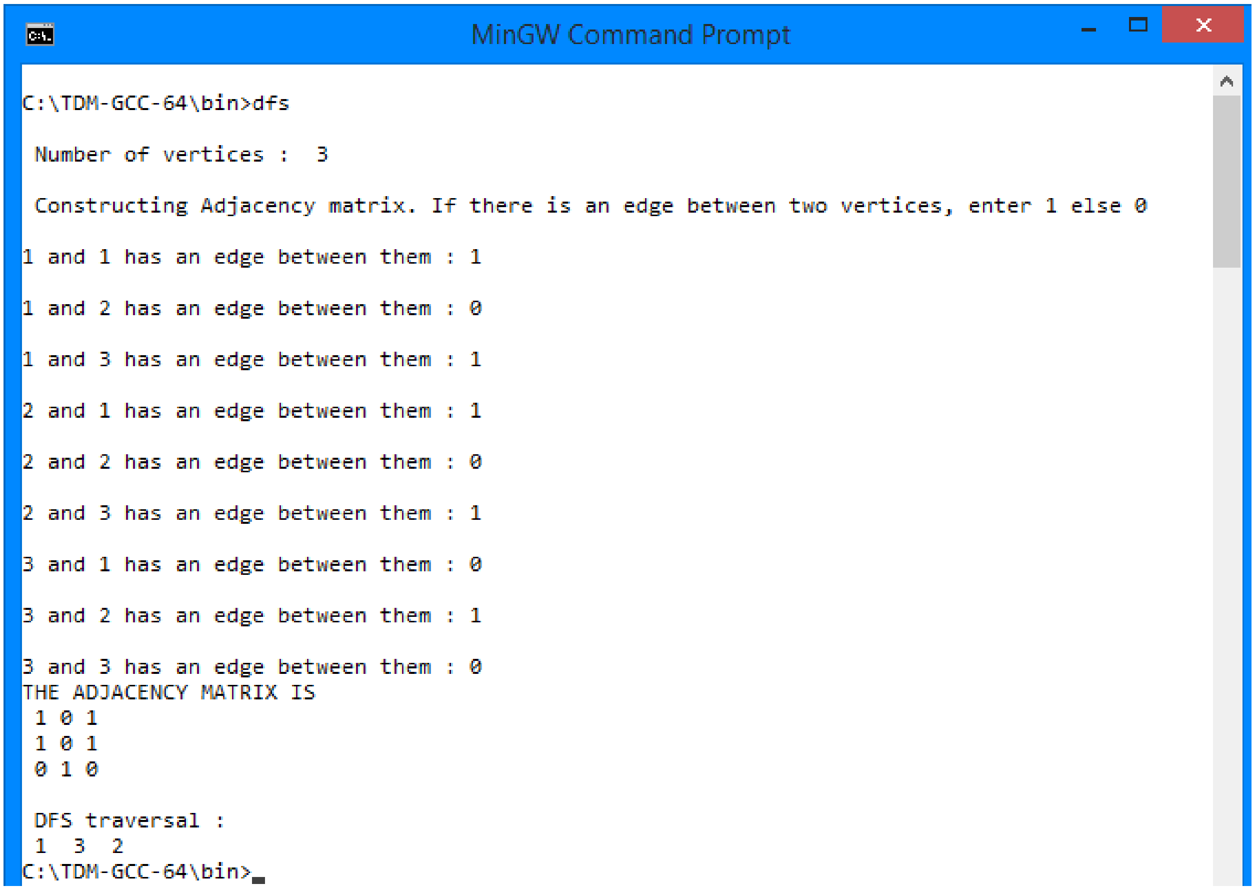
```
#include<stdio.h>
#define MAX 10

int Binary(int arr[],int n,int key)
{
 int i,pos=-1, HIGH=n-1, LOW=0, MID;
 for(i=0;i<n;i++)
 {      MID=(HIGH+LOW)/2;

       if(key==arr[MID])
       {
             pos=MID;
             break;
       }
       else if(key<=arr[MID])
             HIGH=MID-1;
       else
             LOW=MID+1;
 }
 return pos;
}

Int main()
{
 int arr[MAX], n,i,key,pos;
 printf("Enter Length of the Array\n");
 scanf("%d",&n);

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

 printf("Enter Element to be searched\n");
 scanf("%d",&key);

 pos=Binary(arr,n,key);

 if(pos==-1)
       printf("Element not present in the list\n");
 else
       printf("Element found at %d position\n",pos+1);
return 0;
}
```



```
C:\TDM-GCC-64\bin>binary
Enter Length of the Array
5
Enter Array
1
5
7
36
98
Enter Element to be searched
7
Element found at 3 position
```

6. DFS

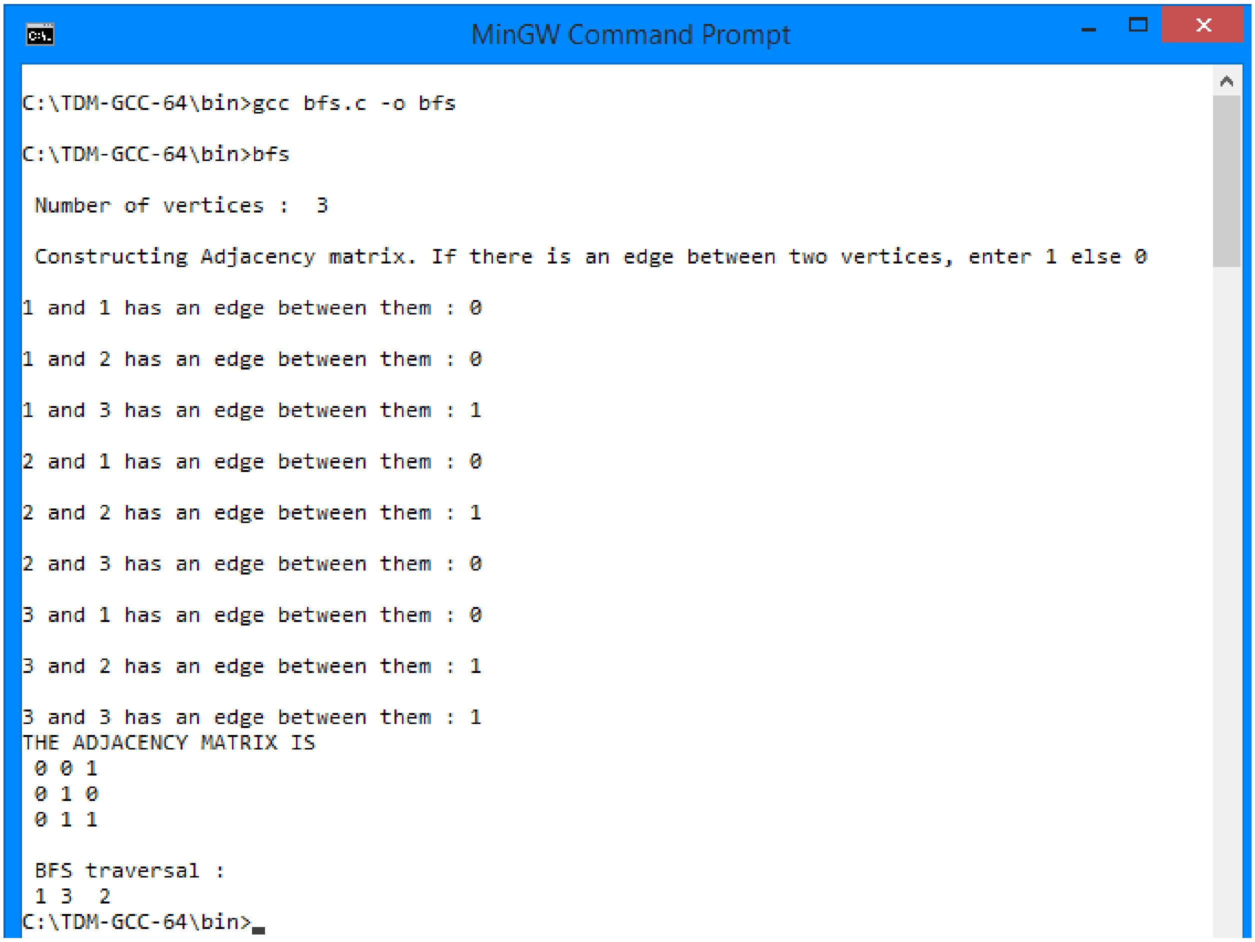
```
#include<stdio.h>

int q[20],top=-1,front=-1,rear=-1,a[20][20],vis[20],stack[20];
int delete();
void add(int item);
void bfs(int s,int n);
void push(int item);
int pop();

void dfs(int s, int n)
{
	int i, k;
	push(s);
	vis[s] = 1;
	k = pop();

	if (k != 0)
		printf(" %d ", k);

	while (k != 0)
	{
		for (i = 1; i <= n; i++)
		if ((a[k][i] != 0) && (vis[i] == 0))
		{
			push(i);
			vis[i] = 1;
		}

		k = pop();
		if (k != 0)
			printf(" %d ", k);
	}
	for (i = 1; i <= n; i++)
		if (vis[i] == 0)
			dfs(i, n);
}

void push(int item)
{
	if (top == 19)
		printf("Stack overflow ");
	else
		stack[++top] = item;
}
int pop()
{
	int k;
	if (top == -1)
		return (0);
	else
	{
		k = stack[top--];
		return (k);
	}
}

int main()
{
    int n,i,s,ch,j;
    char c,dummy;

    printf("\n Number of vertices :  ");
    scanf("%d",&n);

      printf("\n Constructing Adjacency matrix. If there is an edge between two
vertices, enter 1 else 0 \n");

    for(i=1;i<=n;i++)
    {
        for(j=1;j<=n;j++)
        {
            printf("\n%d and %d has an edge between them : ",i,j);
            scanf("%d",&a[i][j]);
        }
    }

    printf("THE ADJACENCY MATRIX IS\n");
    for(i=1;i<=n;i++)
    {
        for(j=1;j<=n;j++)
        {
            printf(" %d",a[i][j]);
        }
        printf("\n");
    }

      printf("\n DFS traversal : \n");

      dfs(s,n);

      return 0;
}
```



```
C:\TDM-GCC-64\bin>dfs

 Number of vertices :  3

 Constructing Adjacency matrix. If there is an edge between two vertices, enter 1 else 0

1 and 1 has an edge between them : 1

1 and 2 has an edge between them : 0

1 and 3 has an edge between them : 1

2 and 1 has an edge between them : 1

2 and 2 has an edge between them : 0

2 and 3 has an edge between them : 1

3 and 1 has an edge between them : 0

3 and 2 has an edge between them : 1

3 and 3 has an edge between them : 0
THE ADJACENCY MATRIX IS
 1 0 1
 1 0 1
 0 1 0

 DFS traversal :
 1  3  2
C:\TDM-GCC-64\bin>
```

7. BFS

```
#include<stdio.h>

int q[20],top=-1,front=-1,rear=-1,a[20][20],vis[20],stack[20];
int delete();
void add(int item);
void bfs(int s,int n);
void push(int item);
int pop();

void bfs(int s, int n)
{
	int p, i;
	add(s);
	vis[s] = 1;
	p = delete();
	if (p != 0)
		printf(" %d", p);

	while (p != 0)
	{
		for (i = 1; i <= n; i++)
			if ((a[p][i] != 0) && (vis[i] == 0))
			{
				add(i);
				vis[i] = 1;
			}

		p = delete();

		if (p != 0)
			printf(" %d ", p);
	}

	for (i = 1; i <= n; i++)
		if (vis[i] == 0)
			bfs(i, n);
}


void add(int item)
{
	if (rear == 19)
		printf("QUEUE FULL");
	else
	{
		if (rear == -1)
		{
			q[++rear] = item;
			front++;
		}
		else
			q[++rear] = item;
	}
}

int delete()
{
       int k;
       if ((front > rear) || (front == -1))
             return (0);
       else
       {
             k = q[front++];
             return (k);
       }
}

int main()
{
    int n,i,s,ch,j;
    char c,dummy;

    printf("\n Number of vertices :  ");
    scanf("%d",&n);

       printf("\n Constructing Adjacency matrix. If there is an edge between two
vertices, enter 1 else 0 \n");

    for(i=1;i<=n;i++)
    {
        for(j=1;j<=n;j++)
        {
            printf("\n%d and %d has an edge between them : ",i,j);
            scanf("%d",&a[i][j]);
        }
    }

    printf("THE ADJACENCY MATRIX IS\n");
    for(i=1;i<=n;i++)
    {
        for(j=1;j<=n;j++)
        {
            printf(" %d",a[i][j]);
        }
        printf("\n");
    }

       printf("\n BFS traversal : \n");

       bfs(s,n);

       return 0;
}
```

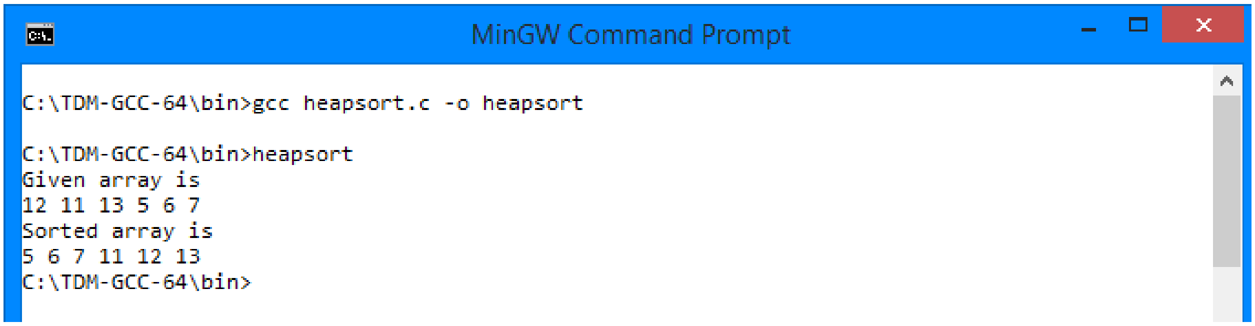


```
C:\TDM-GCC-64\bin>gcc bfs.c -o bfs

C:\TDM-GCC-64\bin>bfs

 Number of vertices :  3

 Constructing Adjacency matrix. If there is an edge between two vertices, enter 1 else 0

1 and 1 has an edge between them : 0

1 and 2 has an edge between them : 0

1 and 3 has an edge between them : 1

2 and 1 has an edge between them : 0

2 and 2 has an edge between them : 1

2 and 3 has an edge between them : 0

3 and 1 has an edge between them : 0

3 and 2 has an edge between them : 1

3 and 3 has an edge between them : 1
THE ADJACENCY MATRIX IS
 0 0 1
 0 1 0
 0 1 1

 BFS traversal :
 1 3  2
C:\TDM-GCC-64\bin>
```

8. Heap and heap sort

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

typedef struct MaxHeap MaxHeap;

struct MaxHeap
{
    int size;
    int* array;
};

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

void maxHeapify(MaxHeap* maxHeap, int index)
{
    int largest = index;
    int left = 2 * index + 1;
    int right = 2 * index + 2;

    if ((left < maxHeap -> size) && (maxHeap -> array[left] > maxHeap ->
array[largest]))
        largest = left;

    if ((right < maxHeap -> size) && (maxHeap -> array[right] > maxHeap ->
array[largest]))
        largest = right;

    if (largest != index)
    {
        swap(&(maxHeap->array[largest]), &(maxHeap->array[index]));
        maxHeapify(maxHeap, largest);
    }
}

MaxHeap* createAndBuildHeap(int *array, int size)
{
    int index;
    MaxHeap* maxHeap = (MaxHeap*) malloc(sizeof(MaxHeap));

       maxHeap -> size = size;
    maxHeap -> array = array;

    for (index = ((maxHeap -> size) - 2) / 2; index >= 0; --index)
        maxHeapify(maxHeap, index);

       return maxHeap;
}
```

```
void heapSort(int* array, int size)
{
    MaxHeap* maxHeap = createAndBuildHeap(array, size);

    while (maxHeap -> size > 1)
    {
        swap(&(maxHeap -> array[0]), &(maxHeap -> array[maxHeap -> size - 1]));
        --(maxHeap -> size);

        maxHeapify(maxHeap, 0);
    }
}

void printArray(int* arr, int size)
{
    int index;
    for (index = 0; index < size; ++index)
        printf("%d ", arr[index]);
}

int main()
{
    int arr[] = {12, 11, 13, 5, 6, 7};
    int size = sizeof(arr)/sizeof(arr[0]);

    printf("Given array is \n");
    printArray(arr, size);

    heapSort(arr, size);

    printf("\nSorted array is \n");
    printArray(arr, size);
    return 0;
}
```

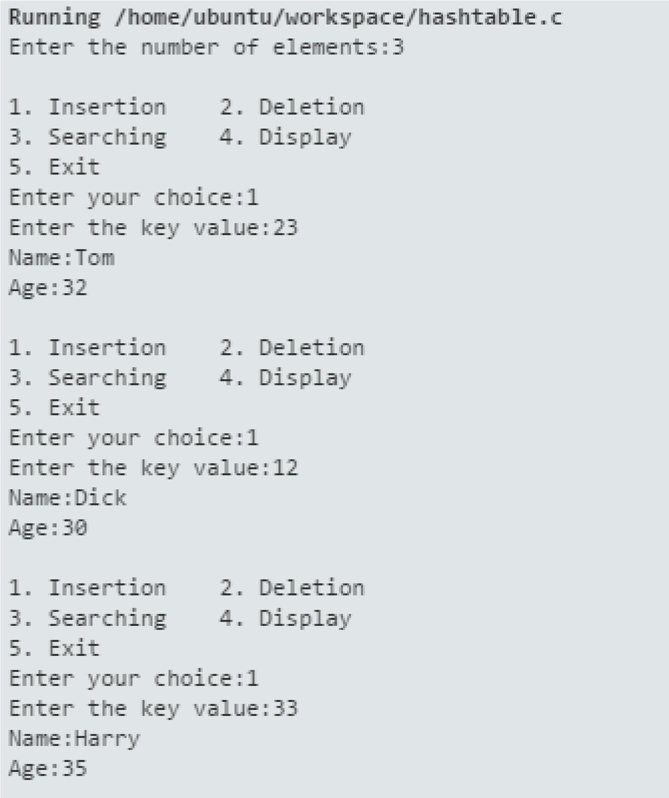


```
C:\TDM-GCC-64\bin>gcc heapsort.c -o heapsort

C:\TDM-GCC-64\bin>heapsort
Given array is
12 11 13 5 6 7
Sorted array is
5 6 7 11 12 13
C:\TDM-GCC-64\bin>
```

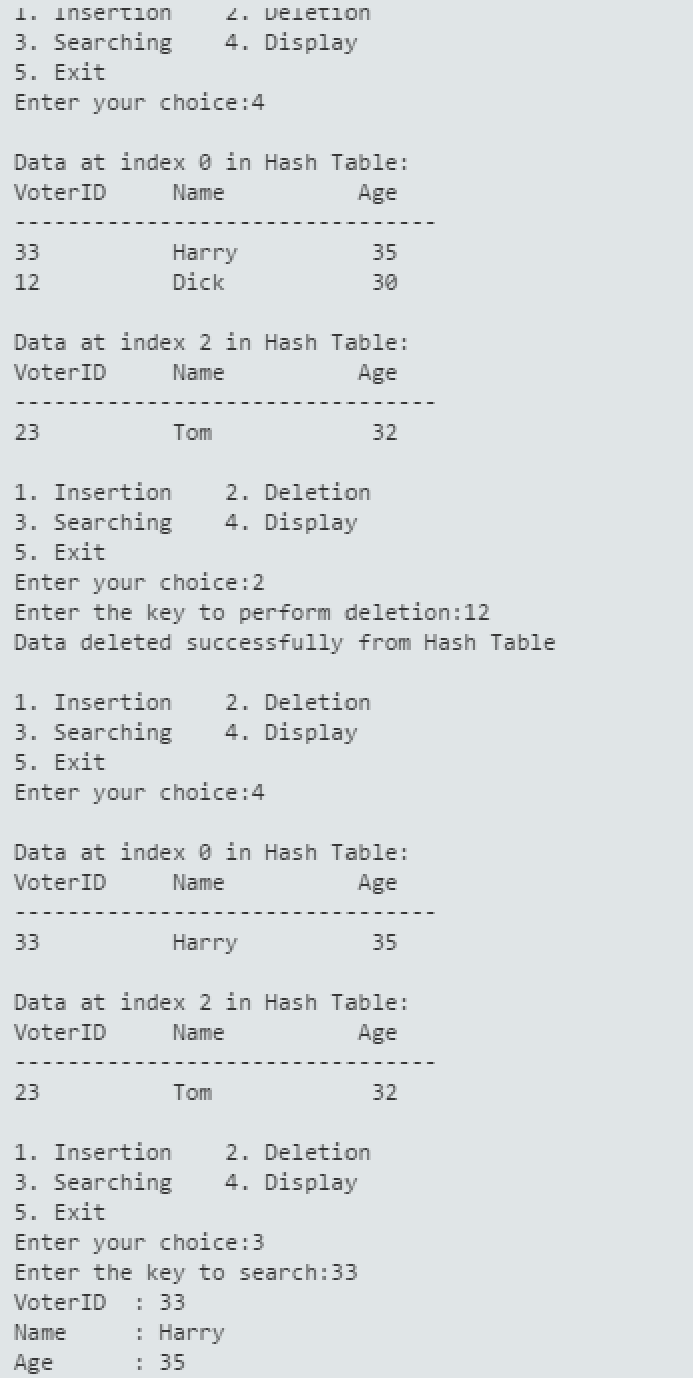
9. Hash table

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

struct hash *hashTable = NULL;
int eleCount = 0;
struct node {
    int key, age;
    char name[100];
    struct node *next;
};
struct hash {
    struct node *head;
    int count;
};
struct node * createNode(int key, char *name, int age) {
    struct node *newnode;
    newnode = (struct node *)malloc(sizeof(struct node));
    newnode->key = key;
    newnode->age = age;
    strcpy(newnode->name, name);
    newnode->next = NULL;
    return newnode;
}
void insertToHash(int key, char *name, int age) {
    int hashIndex = key % eleCount;
    struct node *newnode =  createNode(key, name, age);
    /* head of list for the bucket with index "hashIndex" */
    if (!hashTable[hashIndex].head) {
            hashTable[hashIndex].head = newnode;
            hashTable[hashIndex].count = 1;
            return;
    }
    /* adding new node to the list */
    newnode->next = (hashTable[hashIndex].head);
    /*
     * update the head of the list and no of
     * nodes in the current bucket
     */
    hashTable[hashIndex].head = newnode;
    hashTable[hashIndex].count++;
    return;
}
void deleteFromHash(int key) {
    /* find the bucket using hash index */
    int hashIndex = key % eleCount, flag = 0;
    struct node *temp, *myNode;
    /* get the list head from current bucket */
    myNode = hashTable[hashIndex].head;
    if (!myNode) {
            printf("Given data is not present in hash Table!!\n");
            return;   }
    temp = myNode;
    while (myNode != NULL) {
            /* delete the node with given key */
            if (myNode->key == key) {
                    flag = 1;
                    if (myNode == hashTable[hashIndex].head)
                            hashTable[hashIndex].head = myNode->next;
                    else
                            temp->next = myNode->next;
                    hashTable[hashIndex].count--;
                    free(myNode);
                    break;    }
            temp = myNode;
            myNode = myNode->next;
    }
    if (flag)
            printf("Data deleted successfully from Hash Table\n");
    else
            printf("Given data is not present in hash Table!!!!\n");
    return;
}
void searchInHash(int key) {
    int hashIndex = key % eleCount, flag = 0;
    struct node *myNode;
    myNode = hashTable[hashIndex].head;
    if (!myNode) {
            printf("Search element unavailable in hash table\n");
            return;
    }
   while (myNode != NULL) {
            if (myNode->key == key) {
                    printf("VoterID  : %d\n", myNode->key);
                    printf("Name     : %s\n", myNode->name);
                    printf("Age      : %d\n", myNode->age);
                    flag = 1;
                    break;   }
            myNode = myNode->next;
    }
    if (!flag)
            printf("Search element unavailable in hash table\n");
    return;
}
void display() {
    struct node *myNode;
    int i;
    for (i = 0; i < eleCount; i++) {
            if (hashTable[i].count == 0)
                    continue;
            myNode = hashTable[i].head;
            if (!myNode)
                    continue;
            printf("\nData at index %d in Hash Table:\n", i);
            printf("VoterID     Name          Age   \n");
            printf("--------------------------------\n");
            while (myNode != NULL) {
                    printf("%-12d", myNode->key);
                    printf("%-15s", myNode->name);
                    printf("%d\n", myNode->age);
                    myNode = myNode->next;
            }
    }
    return;
}
int main() {
    int n, ch, key, age;
    char name[100];
    printf("Enter the number of elements:");
    scanf("%d", &n);
    eleCount = n;
    /* create hash table with "n" no of buckets */
    hashTable = (struct hash *)calloc(n, sizeof (struct hash));
    while (1) {
            printf("\n1. Insertion\t2. Deletion\n");
            printf("3. Searching\t4. Display\n5. Exit\n");
            printf("Enter your choice:");
            scanf("%d", &ch);
            switch (ch) {
                    case 1:
                            printf("Enter the key value:");
                            scanf("%d", &key);
                            getchar();
                            printf("Name:");
                            fgets(name, 100, stdin);
                            name[strlen(name) - 1] = '\0';
                            printf("Age:");
                            scanf("%d", &age);
                            /*inserting new node to hash table */
                            insertToHash(key, name, age);
                            break;

                    case 2:
                            printf("Enter the key to perform deletion:");
                            scanf("%d", &key);
                            /* delete node with "key" from hash table */
                            deleteFromHash(key);
                            break;
                    case 3:
                            printf("Enter the key to search:");
                            scanf("%d", &key);
                            searchInHash(key);
                            break;
                    case 4:
                            display();
                            break;
                    case 5:
                            exit(0);
                    default:
                            printf("U have entered wrong option!!\n");
                            break;
            }
    }
    return 0;
```

```
}
```



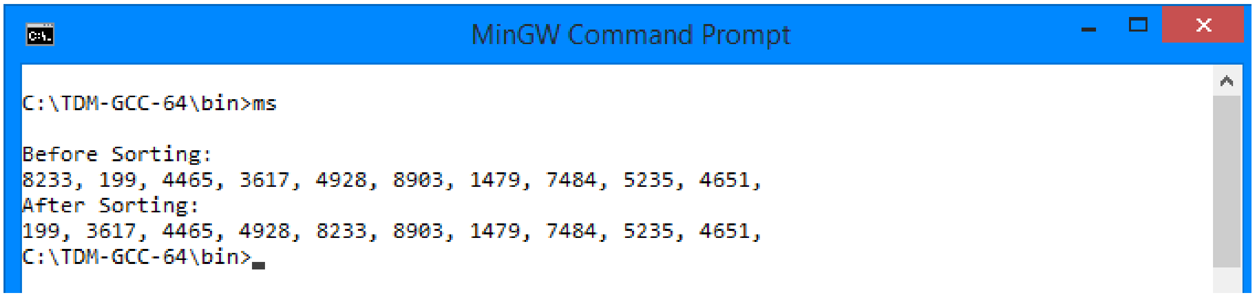
```
Running /home/ubuntu/workspace/hashtable.c
Enter the number of elements:3

1. Insertion    2. Deletion
3. Searching    4. Display
5. Exit
Enter your choice:1
Enter the key value:23
Name:Tom
Age:32

1. Insertion    2. Deletion
3. Searching    4. Display
5. Exit
Enter your choice:1
Enter the key value:12
Name:Dick
Age:30

1. Insertion    2. Deletion
3. Searching    4. Display
5. Exit
Enter your choice:1
Enter the key value:33
Name:Harry
Age:35
```



```
1. Insertion    2. Deletion
3. Searching    4. Display
5. Exit
Enter your choice:4

Data at index 0 in Hash Table:
VoterID     Name          Age
--------------------------------
33          Harry          35
12          Dick           30

Data at index 2 in Hash Table:
VoterID     Name          Age
--------------------------------
23          Tom            32

1. Insertion    2. Deletion
3. Searching    4. Display
5. Exit
Enter your choice:2
Enter the key to perform deletion:12
Data deleted successfully from Hash Table

1. Insertion    2. Deletion
3. Searching    4. Display
5. Exit
Enter your choice:4

Data at index 0 in Hash Table:
VoterID     Name          Age
--------------------------------
33          Harry          35

Data at index 2 in Hash Table:
VoterID     Name          Age
--------------------------------
23          Tom            32

1. Insertion    2. Deletion
3. Searching    4. Display
5. Exit
Enter your choice:3
Enter the key to search:33
VoterID  : 33
Name     : Harry
Age      : 35
```

10. Merge sort

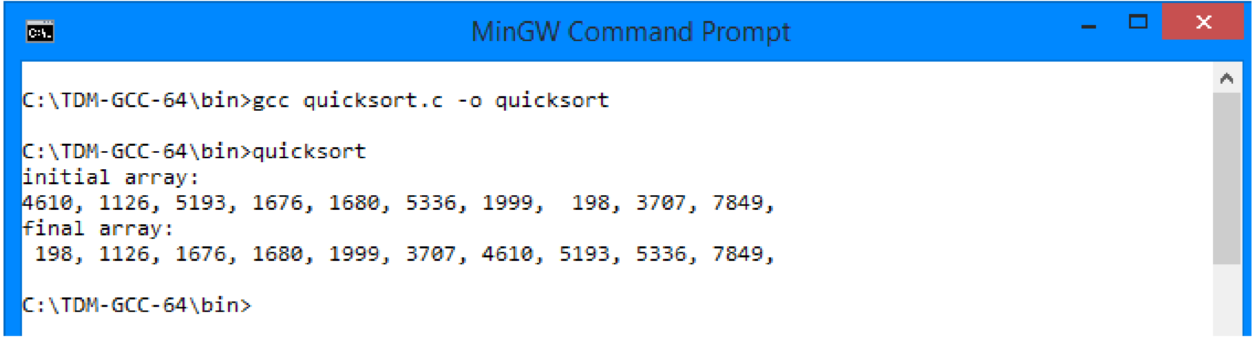
```
#include <stdio.h>
#include <stdlib.h>

#define SIZE 10
#define SEED 9999
void Merge(int[], int, int, int);
void DisplayArray(int[], int);

void MergeSort(int arr[], int startIndex, int endIndex)
{
        int mid;
        if(startIndex >= endIndex)
                return;
        mid = (endIndex + startIndex) / 2;
        MergeSort(arr, startIndex, mid);
        MergeSort(arr, mid+1, endIndex);
        Merge(arr, startIndex, mid, endIndex);
}

void Merge(int arr[], int startIndex, int mid, int endIndex)
{
        int i, j, k;
        int *workingArr = malloc(sizeof(int) * (endIndex - startIndex) + 1);
        for(i = startIndex, j = mid + 1, k = 0; i <= mid && j<= endIndex; k++)
        {
                if(arr[i] < arr[j])
                {
                        workingArr[k] = arr[i];
                        i++;
                }
                else
                {
                        workingArr[k] = arr[j];
                        j++;
                }
        }
        for( ; i <= mid; i++)
        {
                workingArr[k++] = arr[i];
        }
        for( ; j <= endIndex; j++)
        {
                workingArr[k++] = arr[j];
        }
        for(i = startIndex, k=0; i <= endIndex; i++, k++)
        {
                arr[i] = workingArr[k];
        }
}

void DisplayArray(int arr[], int arrLength)
{
        int i;
        for(i = 0; i < arrLength; i++)
        {
                printf("%d, ", arr[i]);
        }
}

int main()
{
        time_t t;
    srand((unsigned) time(&t));
        int arr[SIZE],i;
        for(i=0;i<SIZE;i++)
          arr[i]=rand()%SEED;

        printf("\nBefore Sorting:\n");
        DisplayArray(arr, SIZE);
        MergeSort(arr, 0, 4);
        printf("\nAfter Sorting:\n");
        DisplayArray(arr, SIZE);
}
```



```
C:\TDM-GCC-64\bin>ms

Before Sorting:
8233, 199, 4465, 3617, 4928, 8903, 1479, 7484, 5235, 4651,
After Sorting:
199, 3617, 4465, 4928, 8233, 8903, 1479, 7484, 5235, 4651,
C:\TDM-GCC-64\bin>
```

11. Quick sort

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

#define SIZE 20
#define SEED 9999

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

void print(int array[])
{
    int i;
    for(i=0;i<SIZE;i++)
        printf("%4d, ",array[i]);
    printf("\n");
}

int randpartition(int p, int r)
{
    int i;
    time_t t;
    srand((unsigned) time(&t));

    i=p+rand()%(r-p+1);

    return i;
}

int partition(int array[],int p, int r)
{
    int x= randpartition(p,r), i = p-1, j, pivot=array[x];
    swap(&array[x],&array[r]);
    for(j=p;j<r;j++)
    {
        if(array[j]<pivot)
        {
            i++;
            swap(&array[i],&array[j]);
        }
    }
    swap(&array[i+1],&array[r]);
    return i+1;
}

void quicksort(int array[],int p, int r)
{

    int q;
    if(p<r)
    {
        q= partition(array,p,r);
        quicksort(array,p, q-1);
        quicksort(array,q+1,r);
    }

}

int main()
{
    int array[SIZE] , i;

    time_t t;
    srand((unsigned) time(&t));
    for(i=0;i<SIZE;i++)
        array[i]=rand()%SEED;

    printf("initial array:\n");
    print(array);

    quicksort(array,0, SIZE-1);

    printf("final array:\n");
    print(array);

    return 0;
}
```



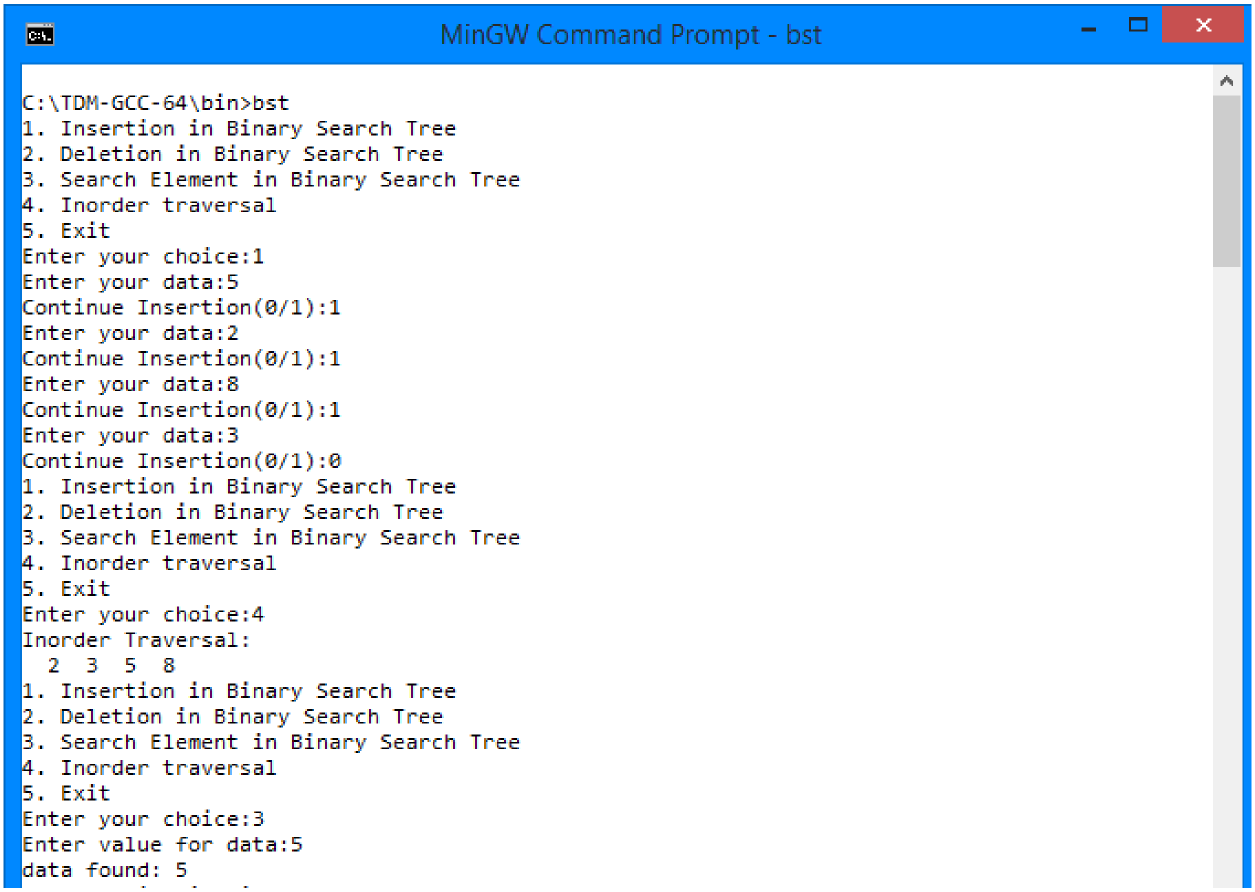
```
C:\TDM-GCC-64\bin>gcc quicksort.c -o quicksort

C:\TDM-GCC-64\bin>quicksort
initial array:
4610, 1126, 5193, 1676, 1680, 5336, 1999,  198, 3707, 7849,
final array:
 198, 1126, 1676, 1680, 1999, 3707, 4610, 5193, 5336, 7849,

C:\TDM-GCC-64\bin>
```

12. BST

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

typedef struct treeNode treeNode;

struct treeNode
{
    int data;
    treeNode *left, *right;
};

treeNode *root = NULL;

treeNode* createNode(int data)
{
    treeNode *newNode;
    newNode = (treeNode *) malloc(sizeof (treeNode));
    newNode->data = data;
    newNode->left = NULL;
    newNode->right = NULL;
    return(newNode);
}


void insertion(treeNode **node, int data)
{
    if (*node == NULL)
        *node = createNode(data);
    else if (data < (*node)->data)
        insertion(&(*node)->left, data);
    else if (data > (*node)->data)
        insertion(&(*node)->right, data);
}


void deletion(treeNode **node, treeNode **parent, int data)
{
    treeNode *tmpNode, *tmpParent;

    if (*node == NULL)
            return;
    if ((*node)->data == data) {
            if (!(*node)->left && !(*node)->right)
            {
                if (parent)
                {
                    if ((*parent)->left == *node)
                        (*parent)->left = NULL;
                    else
                        (*parent)->right = NULL;

                    free(*node);
                }
```

```
                                else
                                        free(*node);
                        }
                        else if (!(*node)->right && (*node)->left)
                        {
                                tmpNode = *node;
                                (*parent)->right = (*node)->left;
                                free(tmpNode);
                                *node = (*parent)->right;
                        }
                        else if ((*node)->right && !(*node)->left)
                        {
                                tmpNode = *node;
                                (*parent)->left = (*node)->right;
                                free(tmpNode);
                                (*node) = (*parent)->left;
                        }
                        else if (!(*node)->right->left)
                        {
                                tmpNode = *node;
                                (*node)->right->left = (*node)->left;
                                (*parent)->left = (*node)->right;
                                free(tmpNode);
                                *node = (*parent)->left;
                        }
                        else
                        {
                                tmpNode = (*node)->right;
                                while (tmpNode->left)
                                {
                                                tmpParent = tmpNode;
                                                tmpNode = tmpNode->left;
                                }
                                tmpParent->left = tmpNode->right;
                                tmpNode->left = (*node)->left;
                                tmpNode->right =(*node)->right;
                                free(*node);
                                *node = tmpNode;
                        }
        }
        else if (data < (*node)->data)
                deletion(&(*node)->left, node, data);
        else if (data > (*node)->data)
                deletion(&(*node)->right, node, data);

}

void findElement(struct treeNode *node, int data)
{
        if (!node)
                        return;
        else if (data < node->data)
                findElement(node->left, data);
        else if (data > node->data)
                findElement(node->right, data);
```

```
    else
        printf("data found: %d\n", node->data);
    return;
}

void traverse(struct treeNode *node)
{
    if (node != NULL)
    {
        traverse(node->left);
        printf("%3d", node->data);
        traverse(node->right);
    }
    return;
}

int main() {

    int data, ch;

    while (1)
    {
            printf("1. Insertion in Binary Search Tree\n");
            printf("2. Deletion in Binary Search Tree\n");
            printf("3. Search Element in Binary Search Tree\n");
            printf("4. Inorder traversal\n5. Exit\n");
            printf("Enter your choice:");
            scanf("%d", &ch);

            switch (ch)
            {
                    case 1:
                            while (1)
                            {
                                printf("Enter your data:");
                                scanf("%d", &data);
                                insertion(&root, data);
                                printf("Continue
Insertion(0/1):");
                                scanf("%d", &ch);
                                if (!ch)
                                    break;
                            }
                            break;
                    case 2:
                            printf("Enter your data:");
                            scanf("%d", &data);
                            deletion(&root, NULL, data);
                            break;
                    case 3:
                            printf("Enter value for data:");
                            scanf("%d", &data);
                            findElement(root, data);
                            break;
                    case 4:
                            printf("Inorder Traversal:\n");
                            traverse(root);
                            printf("\n");
                            break;
                    case 5:
                            exit(0);
                    default:
                            printf("u've entered wrong option\n");
                            break;
            }
    }
    return 0;

}
```

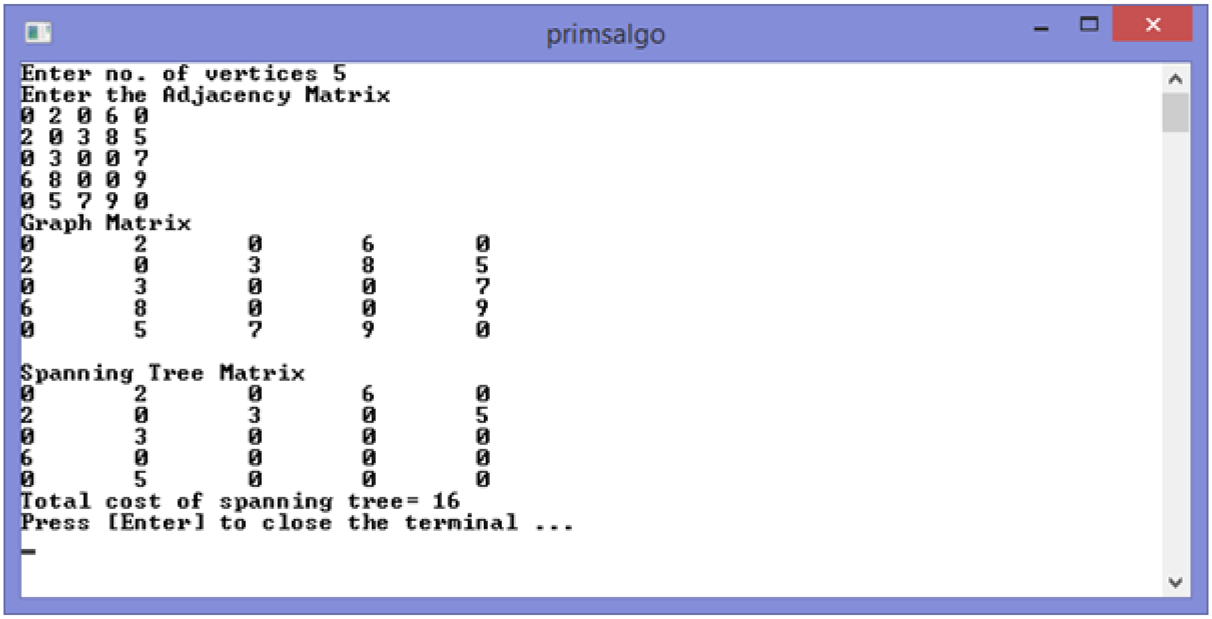


```
C:\TDM-GCC-64\bin>bst
1. Insertion in Binary Search Tree
2. Deletion in Binary Search Tree
3. Search Element in Binary Search Tree
4. Inorder traversal
5. Exit
Enter your choice:1
Enter your data:5
Continue Insertion(0/1):1
Enter your data:2
Continue Insertion(0/1):1
Enter your data:8
Continue Insertion(0/1):1
Enter your data:3
Continue Insertion(0/1):0
1. Insertion in Binary Search Tree
2. Deletion in Binary Search Tree
3. Search Element in Binary Search Tree
4. Inorder traversal
5. Exit
Enter your choice:4
Inorder Traversal:
  2  3  5  8
1. Insertion in Binary Search Tree
2. Deletion in Binary Search Tree
3. Search Element in Binary Search Tree
4. Inorder traversal
5. Exit
Enter your choice:3
Enter value for data:5
data found: 5
```

13. Prims

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

#define infinity 9999
#define MAX 20

void prims(int G[][MAX],int n);

int main()
{
	int i,j,total_cost;
	int G[MAX][MAX],n;
	printf("Enter no. of vertices ");
	scanf("%d",&n);
	printf("Enter the Adjacency Matrix ");
	for(i=0;i<n;i++)
		for(j=0;j<n;j++)
			scanf("%d",&G[i][j]);
	printf("Graph Matrix ");
	for(i=0;i<n;i++)
	{
		printf("\n");
		for(j=0;j<n;j++)
			printf("%d\t",G[i][j]);
	}
	prims(G,n);
	return 0;
}

void prims(int G[][MAX], int n)
{
	int cost[MAX][MAX];
	int spanning[MAX][MAX];
	int u,v,min_distance,distance[MAX],from[MAX];
	int visited[MAX],no_of_edges,i,min_cost,j;
	for(i=0;i<n;i++)
	for(j=0;j<n;j++)
	{
		if(G[i][j]==0)
			cost[i][j]=infinity;
		else
			cost[i][j]=G[i][j];
		spanning[i][j]=0;
	}
	distance[0]=0;
	visited[0]=1;
	for(i=1;i<n;i++)
	{
		distance[i]=cost[0][i];
		from[i]=0;
		visited[i]=0;
	}
	min_cost=0;
```

```
        no_of_edges=n-1;
        while(no_of_edges>0)
        {
                min_distance=infinity;
                for(i=1;i<n;i++)
                        if(visited[i]==0&&distance[i]<min_distance)
                        {
                                v=i;
                                min_distance=distance[i];
                        }
                u=from[v];
                spanning[u][v]=distance[v];
                spanning[v][u]=distance[v];
                no_of_edges--;
                visited[v]=1;
                for(i=1;i<n;i++)
                        if(visited[i]==0&&cost[i][v]<distance[i])
                        {
                                distance[i]=cost[i][v];
                                from[i]=v;
                        }
                min_cost=min_cost+cost[u][v];
        }
        printf("\n\nSpanning Tree Matrix ");
        for(i=0;i<n;i++)
        {
                printf("\n");
                for(j=0;j<n;j++)
                        printf("%d\t",spanning[i][j]);
        }
        printf("\nTotal cost of spanning tree= %d \n",min_cost);
}
```

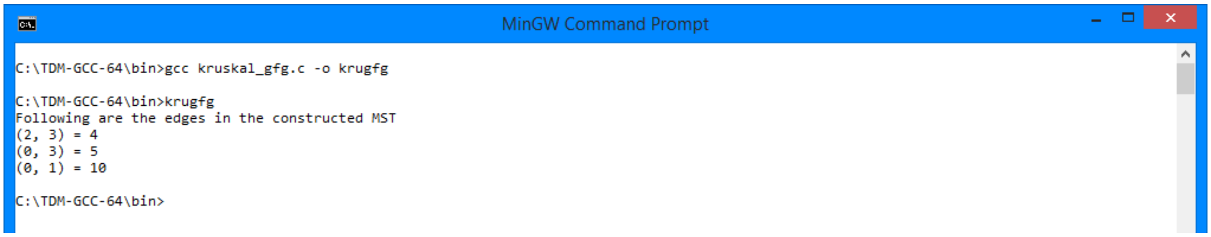


```
Enter no. of vertices 5
Enter the Adjacency Matrix
0 2 0 6 0
2 0 3 8 5
0 3 0 0 7
6 8 0 0 9
0 5 7 9 0
Graph Matrix
0       2       0       6       0
2       0       3       8       5
0       3       0       0       7
6       8       0       0       9
0       5       7       9       0

Spanning Tree Matrix
0       2       0       6       0
2       0       3       0       5
0       3       0       0       0
6       0       0       0       0
0       5       0       0       0
Total cost of spanning tree= 16
Press [Enter] to close the terminal ...
_
```

14. Kruskal

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

struct Edge
{
    int src, dest, weight;
};

struct Graph
{
    int V, E;
    struct Edge* edge;
};

struct Graph* createGraph(int V, int E)
{
    struct Graph* graph = (struct Graph*) malloc( sizeof(struct Graph) );
    graph->V = V;
    graph->E = E;

    graph->edge = (struct Edge*) malloc( graph->E * sizeof( struct Edge ) );

    return graph;
}

struct subset
{
    int parent;
    int rank;
};

int find(struct subset subsets[], int i)
{
if (subsets[i].parent != i)
    subsets[i].parent = find(subsets, subsets[i].parent);
return subsets[i].parent;
}

void Union(struct subset subsets[], int x, int y)
{
    int xroot = find(subsets, x);
    int yroot = find(subsets, y);

    if (subsets[xroot].rank < subsets[yroot].rank)
        subsets[xroot].parent = yroot;
    else if (subsets[xroot].rank > subsets[yroot].rank)
        subsets[yroot].parent = xroot;

    else
    {
        subsets[yroot].parent = xroot;
        subsets[xroot].rank++;
    }
}
```

```
int myComp(const void* a, const void* b)
{
    struct Edge* a1 = (struct Edge*)a;
    struct Edge* b1 = (struct Edge*)b;
    return a1->weight > b1->weight;
}

void KruskalMST(struct Graph* graph)
{
    int v;
    int V = graph->V;
    struct Edge result[V];
    int e = 0;
    int i = 0;
    qsort(graph->edge, graph->E, sizeof(graph->edge[0]), myComp);

    struct subset *subsets =
        (struct subset*) malloc( V * sizeof(struct subset) );

    for (v = 0; v < V; ++v)
    {
        subsets[v].parent = v;
        subsets[v].rank = 0;
    }

    while (e < V - 1)
    {
        struct Edge next_edge = graph->edge[i++];

        int x = find(subsets, next_edge.src);
        int y = find(subsets, next_edge.dest);

        if (x != y)
        {
            result[e++] = next_edge;
            Union(subsets, x, y);
        }
    }

    printf("Following are the edges in the constructed MST\n");
    for (i = 0; i < e; ++i)
        printf("(%d, %d) = %d\n", result[i].src, result[i].dest,
                                                   result[i].weight);
    return;
}

int main()
{
/*
         10
    0--------1
    |  \     |
   6|   5\   |15
    |      \ |
    2--------3
        4       */
    int V = 4;
    int E = 5;
    struct Graph* graph = createGraph(V, E);

    graph->edge[0].src = 0;
    graph->edge[0].dest = 1;
    graph->edge[0].weight = 10;

    graph->edge[1].src = 0;
    graph->edge[1].dest = 2;
    graph->edge[1].weight = 6;

    graph->edge[2].src = 0;
    graph->edge[2].dest = 3;
    graph->edge[2].weight = 5;

    graph->edge[3].src = 1;
    graph->edge[3].dest = 3;
    graph->edge[3].weight = 15;

    graph->edge[4].src = 2;
    graph->edge[4].dest = 3;
    graph->edge[4].weight = 4;

    KruskalMST(graph);

    return 0;
}
```

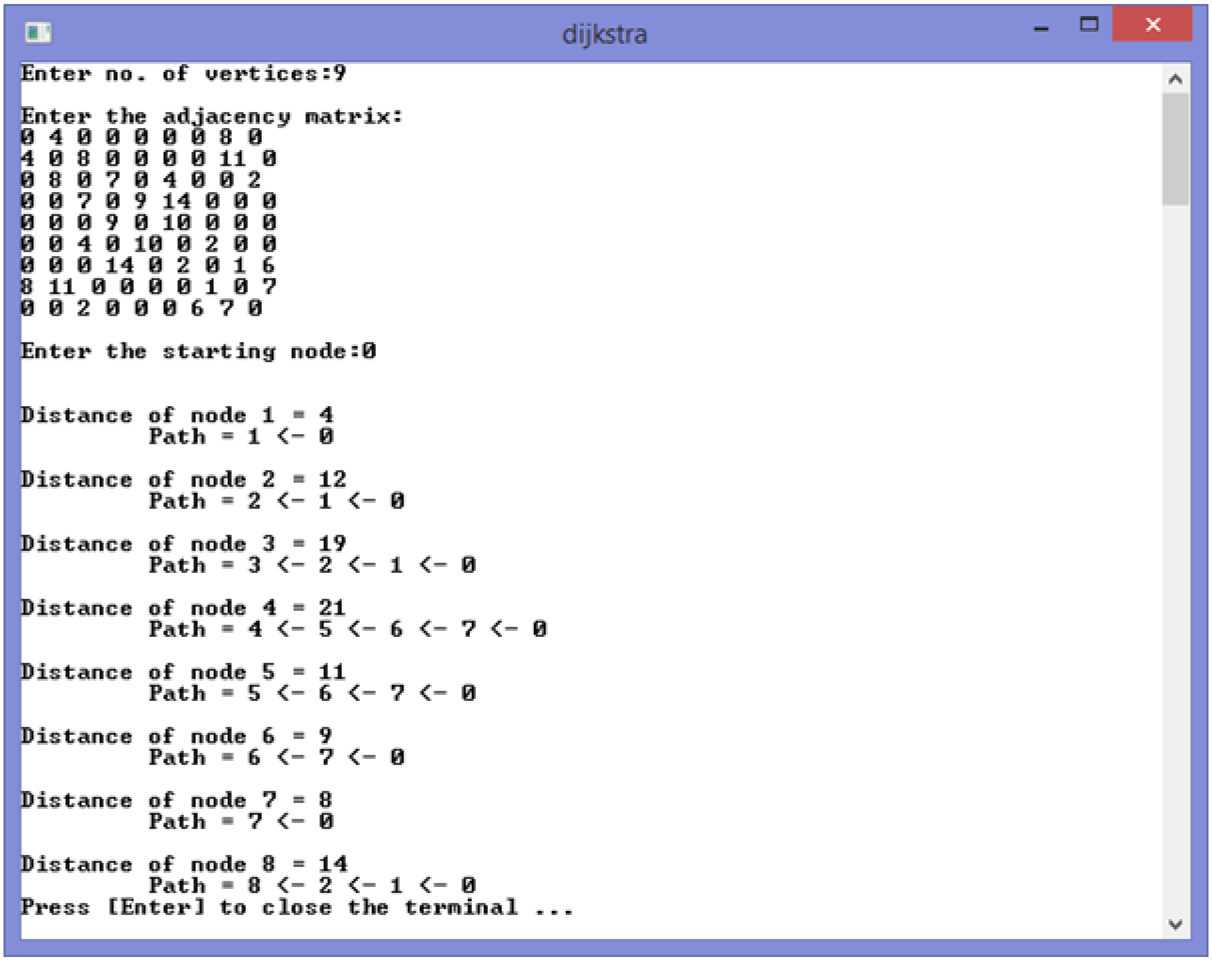


```
C:\TDM-GCC-64\bin>gcc kruskal_gfg.c -o krugfg

C:\TDM-GCC-64\bin>krugfg
Following are the edges in the constructed MST
(2, 3) = 4
(0, 3) = 5
(0, 1) = 10

C:\TDM-GCC-64\bin>
```

15. Dijikstras

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

#define INFINITY 9999
#define MAX 10

void dijkstra(int G[MAX][MAX],int n,int startnode);

int main()
{
	int G[MAX][MAX],i,j,n,u;
	printf("Enter no. of vertices:");
	scanf("%d",&n);
	printf("\nEnter the adjacency matrix:\n");
	for(i=0;i<n;i++)
		for(j=0;j<n;j++)
			scanf("%d",&G[i][j]);
	printf("\nEnter the starting node:");
	scanf("%d",&u);
	dijkstra(G,n,u);
	return 0;
}

void dijkstra(int G[MAX][MAX],int n,int startnode)
{
	int cost[MAX][MAX],distance[MAX],pred[MAX];
	int visited[MAX],count,mindistance,nextnode,i,j;
	for(i=0;i<n;i++)
		for(j=0;j<n;j++)
			if(G[i][j]==0)
				cost[i][j]=INFINITY;
			else
				cost[i][j]=G[i][j];
	for(i=0;i<n;i++)
	{
		distance[i]=cost[startnode][i];
		pred[i]=startnode;
		visited[i]=0;
	}
	distance[startnode]=0;
	visited[startnode]=1;
	count=1;
	while(count<n-1)
	{
		mindistance=INFINITY;
		for(i=0;i<n;i++)
			if(distance[i]<mindistance&&!visited[i])
			{
				mindistance=distance[i];
				nextnode=i;
			}
		visited[nextnode]=1;
		for(i=0;i<n;i++)
```

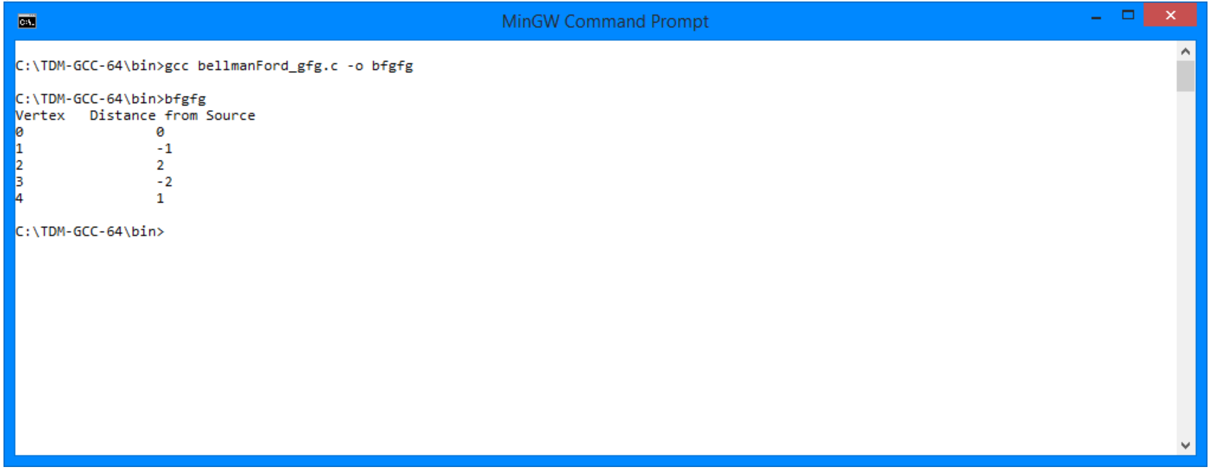
```
                        if(!visited[i])
                                if(mindistance+cost[nextnode][i]<distance[i])
                                {
                                                distance[i]=mindistance+cost[nextnode][i];
                                        pred[i]=nextnode;
                                }
                count++;
        }
        for(i=0;i<n;i++)
                if(i!=startnode)
                {
                        printf("\n\nDistance of node %d = %d",i,distance[i]);
                        printf("\n\t Path = %d",i);
                        j=i;
                        do
                        {
                                j=pred[j];
                                printf(" <- %d",j);
                        }while(j!=startnode);
                }
        printf("\n");
}
```



```
Enter no. of vertices:9

Enter the adjacency matrix:
0 4 0 0 0 0 0 8 0
4 0 8 0 0 0 0 11 0
0 8 0 7 0 4 0 0 2
0 0 7 0 9 14 0 0 0
0 0 0 9 0 10 0 0 0
0 0 4 0 10 0 2 0 0
0 0 0 14 0 2 0 1 6
8 11 0 0 0 0 1 0 7
0 0 2 0 0 0 6 7 0

Enter the starting node:0


Distance of node 1 = 4
         Path = 1 <- 0

Distance of node 2 = 12
         Path = 2 <- 1 <- 0

Distance of node 3 = 19
         Path = 3 <- 2 <- 1 <- 0

Distance of node 4 = 21
         Path = 4 <- 5 <- 6 <- 7 <- 0

Distance of node 5 = 11
         Path = 5 <- 6 <- 7 <- 0

Distance of node 6 = 9
         Path = 6 <- 7 <- 0

Distance of node 7 = 8
         Path = 7 <- 0

Distance of node 8 = 14
         Path = 8 <- 2 <- 1 <- 0
Press [Enter] to close the terminal ...
```

16. Bellman-Ford

```
#include <stdio.h>
#include <stdlib.h>
struct Edge
{
    int src, dest, weight;
};

struct Graph
{
    int V, E;

    struct Edge* edge;
};

struct Graph* createGraph(int V, int E)
{
    struct Graph* graph = (struct Graph*) malloc( sizeof(struct Graph) );
    graph->V = V;
    graph->E = E;

    graph->edge = (struct Edge*) malloc( graph->E * sizeof( struct Edge ) );

    return graph;
}

void printArr(int dist[], int n)
{
    int i;
    printf("Vertex   Distance from Source\n");
    for (i = 0; i < n; ++i)
        printf("%d \t\t %d\n", i, dist[i]);
}

void BellmanFord(struct Graph* graph, int src)
{
    int i, j;
    int V = graph->V;
    int E = graph->E;
    int dist[V];

    for (i = 0; i < V; i++)
        dist[i]   = INT_MAX;
    dist[src] = 0;

    for (i = 1; i <= V-1; i++)
    {
        for (j = 0; j < E; j++)
        {
            int u = graph->edge[j].src;
            int v = graph->edge[j].dest;
            int weight = graph->edge[j].weight;
            if (dist[u] != INT_MAX && dist[u] + weight < dist[v])
                dist[v] = dist[u] + weight;
        }
    }

    for (i = 0; i < E; i++)
    {
        int u = graph->edge[i].src;
        int v = graph->edge[i].dest;
        int weight = graph->edge[i].weight;
        if (dist[u] != INT_MAX && dist[u] + weight < dist[v])
            printf("Graph contains negative weight cycle");
    }

    printArr(dist, V);

    return;
}

int main()
{
    int i,j;
    int V = 5;
    int E = 8;
    struct Graph* graph = createGraph(V, E);
    graph->edge[0].src = 0;
    graph->edge[0].dest = 1;
    graph->edge[0].weight = -1;
    graph->edge[1].src = 0;
    graph->edge[1].dest = 2;
    graph->edge[1].weight = 4;

    graph->edge[2].src = 1;
    graph->edge[2].dest = 2;
    graph->edge[2].weight = 3;

    graph->edge[3].src = 1;
    graph->edge[3].dest = 3;
    graph->edge[3].weight = 2;

    graph->edge[4].src = 1;
    graph->edge[4].dest = 4;
    graph->edge[4].weight = 2;

    graph->edge[5].src = 3;
    graph->edge[5].dest = 2;
    graph->edge[5].weight = 5;

    graph->edge[6].src = 3;
    graph->edge[6].dest = 1;
    graph->edge[6].weight = 1;

    graph->edge[7].src = 4;
    graph->edge[7].dest = 3;
    graph->edge[7].weight = -3;

    BellmanFord(graph, 0);
    return 0;
}
```



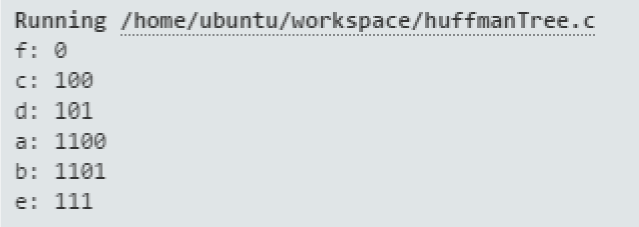
```
C:\TDM-GCC-64\bin>gcc bellmanFord_gfg.c -o bfgfg

C:\TDM-GCC-64\bin>bfgfg
Vertex   Distance from Source
0                0
1                -1
2                2
3                -2
4                1

C:\TDM-GCC-64\bin>
```

17. Huffman tree

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

#define MAX_TREE_HT 100

struct MinHeapNode
{
    char data;
    unsigned freq;
    struct MinHeapNode *left, *right;
};

struct MinHeap
{
    unsigned size;
    unsigned capacity;
    struct MinHeapNode **array;
};

struct MinHeapNode* newNode(char data, unsigned freq)
{
    struct MinHeapNode* temp =
          (struct MinHeapNode*) malloc(sizeof(struct MinHeapNode));
    temp->left = temp->right = NULL;
    temp->data = data;
    temp->freq = freq;
    return temp;
}

struct MinHeap* createMinHeap(unsigned capacity)
{
    struct MinHeap* minHeap = (struct MinHeap*) malloc(sizeof(struct MinHeap));
    minHeap->size = 0;
    minHeap->capacity = capacity;
    minHeap->array = (struct MinHeapNode**)malloc(minHeap->capacity * sizeof(struct
MinHeapNode*));
    return minHeap;
}

void swapMinHeapNode(struct MinHeapNode** a, struct MinHeapNode** b)
{
    struct MinHeapNode* t = *a;
    *a = *b;
    *b = t;
}

void minHeapify(struct MinHeap* minHeap, int idx)
{
    int smallest = idx;
    int left = 2 * idx + 1;
    int right = 2 * idx + 2;

    if (left < minHeap->size && minHeap->array[left]->freq < minHeap-
>array[smallest]->freq)
```

```
      smallest = left;

    if (right < minHeap->size && minHeap->array[right]->freq < minHeap-
>array[smallest]->freq)
      smallest = right;

    if (smallest != idx)
    {
        swapMinHeapNode(&minHeap->array[smallest], &minHeap->array[idx]);
        minHeapify(minHeap, smallest);
    }
}

int isSizeOne(struct MinHeap* minHeap)
{
    return (minHeap->size == 1);
}

struct MinHeapNode* extractMin(struct MinHeap* minHeap)
{
    struct MinHeapNode* temp = minHeap->array[0];
    minHeap->array[0] = minHeap->array[minHeap->size - 1];
    --minHeap->size;
    minHeapify(minHeap, 0);
    return temp;
}

void insertMinHeap(struct MinHeap* minHeap, struct MinHeapNode* minHeapNode)
{
    ++minHeap->size;
    int i = minHeap->size - 1;
    while (i && minHeapNode->freq < minHeap->array[(i - 1)/2]->freq)
    {
        minHeap->array[i] = minHeap->array[(i - 1)/2];
        i = (i - 1)/2;
    }
    minHeap->array[i] = minHeapNode;
}

void buildMinHeap(struct MinHeap* minHeap)
{
    int n = minHeap->size - 1;
    int i;
    for (i = (n - 1) / 2; i >= 0; --i)
        minHeapify(minHeap, i);
}

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

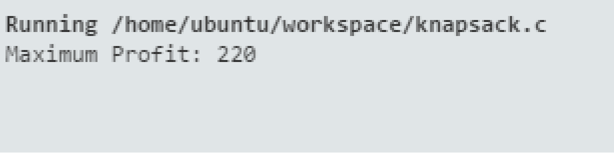
```
int isLeaf(struct MinHeapNode* root)
{
    return !(root->left) && !(root->right) ;
}

struct MinHeap* createAndBuildMinHeap(char data[], int freq[], int size)
{
    struct MinHeap* minHeap = createMinHeap(size);
      int i;
    for (i = 0; i < size; ++i)
        minHeap->array[i] = newNode(data[i], freq[i]);
    minHeap->size = size;
    buildMinHeap(minHeap);
    return minHeap;
}

struct MinHeapNode* buildHuffmanTree(char data[], int freq[], int size)
{
    struct MinHeapNode *left, *right, *top;

    struct MinHeap* minHeap = createAndBuildMinHeap(data, freq, size);

    while (!isSizeOne(minHeap))
    {
        left = extractMin(minHeap);
        right = extractMin(minHeap);

        top = newNode('$', left->freq + right->freq);
        top->left = left;
        top->right = right;
        insertMinHeap(minHeap, top);
    }

    return extractMin(minHeap);
}

void printCodes(struct MinHeapNode* root, int arr[], int top)
{
    if (root->left)
    {
        arr[top] = 0;
        printCodes(root->left, arr, top + 1);
    }

    if (root->right)
    {
        arr[top] = 1;
        printCodes(root->right, arr, top + 1);
    }

    if (isLeaf(root))
    {
        printf("%c: ", root->data);
        printArr(arr, top);
    }
}

void HuffmanCodes(char data[], int freq[], int size)
{
   struct MinHeapNode* root = buildHuffmanTree(data, freq, size);

   int arr[MAX_TREE_HT], top = 0;
   printCodes(root, arr, top);
}

int main()
{
    char arr[] = {'a', 'b', 'c', 'd', 'e', 'f'};
    int freq[] = {5, 9, 12, 13, 16, 45};
    int size = sizeof(arr)/sizeof(arr[0]);
    HuffmanCodes(arr, freq, size);
    return 0;
}
```



```
Running /home/ubuntu/workspace/huffmanTree.c
f: 0
c: 100
d: 101
a: 1100
b: 1101
e: 111
```

18. Knapsack

```
#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 val[] = {60, 100, 120};
    int wt[] = {10, 20, 30};
    int  W = 50;
    int n = sizeof(val)/sizeof(val[0]);
    printf("Maximum Profit: %d", knapSack(W, wt, val, n));
    return 0;
}
```

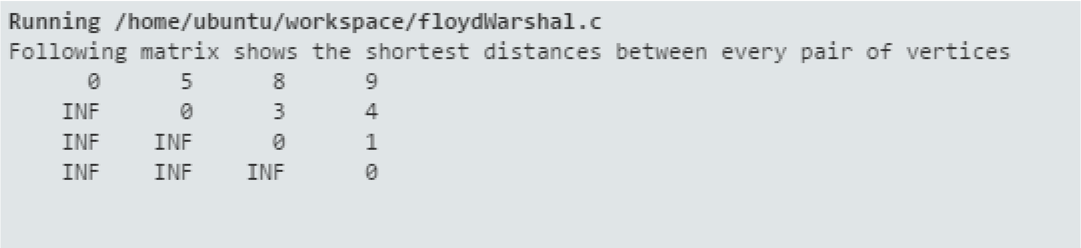


```
Running /home/ubuntu/workspace/knapsack.c
Maximum Profit: 220
```

19. Shortest distance from source to destination by using dynamic programing.

```
#include<stdio.h>

#define V 4

#define INF 99999

void printSolution(int dist[][V]);

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

    for (i = 0; i < V; i++)
        for (j = 0; j < V; j++)
            dist[i][j] = graph[i][j];

    for (k = 0; k < V; k++)
    {
        for (i = 0; i < V; i++)
        {
            for (j = 0; j < V; 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])
{
    int i, j;
    printf ("Following matrix shows the shortest distances"
            " between every pair of vertices \n");
    for (i = 0; i < V; i++)
    {
        for (j = 0; j < V; j++)
        {
            if (dist[i][j] == INF)
                printf("%7s", "INF");
            else
                printf ("%7d", dist[i][j]);
        }
        printf("\n");
    }
}

int main()
{
    /* Let us create the following weighted graph
            10
```

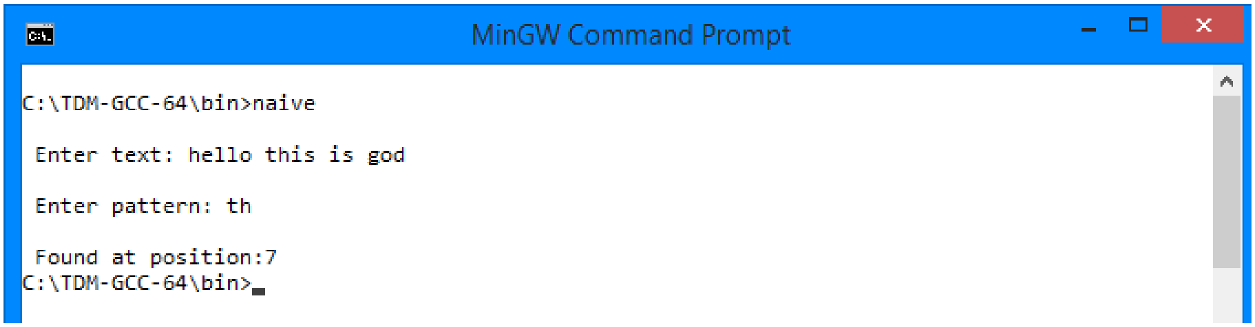
```
       (0)------->(3)
        |         /|\
      5 |          |
        |          | 1
       \|/         |
       (1)------->(2)
            3           */
    int graph[V][V] = { {0,   5,  INF, 10},
                        {INF, 0,   3, INF},
                        {INF, INF, 0,   1},
                        {INF, INF, INF, 0}
                      };

    floydWarshell(graph);
    return 0;
}
```



```
Running /home/ubuntu/workspace/floydWarshal.c
Following matrix shows the shortest distances between every pair of vertices
      0      5      8      9
    INF      0      3      4
    INF    INF      0      1
    INF    INF    INF      0
```

20. Naïve String matching Algorithm

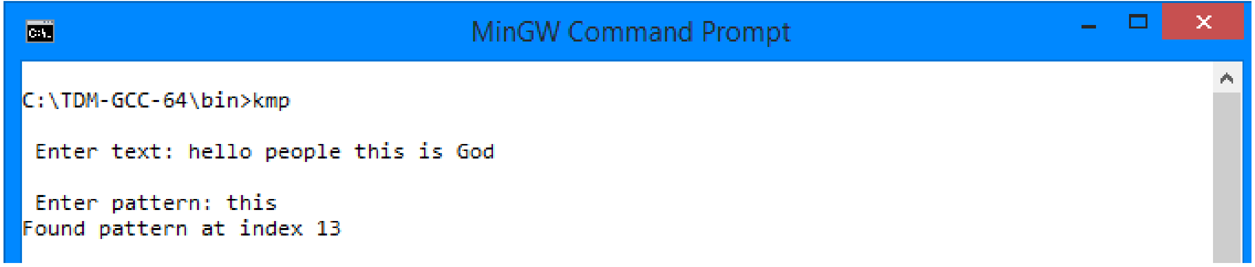
```
#include <stdio.h>
#include <string.h>

int naive_match(char text[], char pattern[])
{
  int i, j, k, text_length, pattern_length, position = -1;

  text_length    = strlen(text);
  pattern_length = strlen(pattern);

  if (pattern_length > text_length) {
    return -1;
  }

  for (i = 0; i <= text_length - pattern_length; i++) {
    position = k = i;

    for (j = 0; j < pattern_length; j++) {
      if (pattern[j] == text[k]) {
        k++;
      }
      else {
        break;
      }
    }
    if (j == pattern_length) {
      return position;
    }
  }

  return -1;
}

int main() {
  char text[100], pattern[100];
  int position;

  printf("\n Enter text: ");
  gets(text);

  printf("\n Enter pattern: ");
  gets(pattern);

  position = naive_match(text, pattern);

  if(position != -1) {
    printf("\n Found at position:%d", position + 1);
  }
  else {
    printf("\n Not found.");
  }
  return 0;
}
```



```
C:\TDM-GCC-64\bin>naive

 Enter text: hello this is god

 Enter pattern: th

 Found at position:7
C:\TDM-GCC-64\bin>
```

21. String matching by Knuth Morris Pratt

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

void computePrefix(char pattern[], int M, int *lps);

int KMPSearch(char pattern[], char *text)
{
    int M = strlen(pattern);
    int N = strlen(text);


    int *lps = (int *)malloc(sizeof(int)*M);
    int j  = 0;
    computePrefix(pattern, M, lps);

    int i = 0;
    while (i < N)
    {
      if (pattern[j] == text[i])
      {
        j++;
        i++;
      }

      if (j == M)
      {
        printf("Found pattern at index %d \n", i-j);
        return 0;
      }

      else if (i < N && pattern[j] != text[i])
      {

        if (j != 0)
         j = lps[j-1];
        else
         i = i+1;
      }

    }
    free(lps);
return -1;
}

void computePrefix(char pattern[], int M, int *lps)
{
    int len = 0;
    int i;

    lps[0] = 0;
    i = 1;
    while (i < M)
    {
       if (pattern[i] == pattern[len])
       {
         len++;
         lps[i] = len;
         i++;
       }
       else
       {
         if (len != 0)
         {

           len = lps[len-1];


         }
         else
         {
           lps[i] = 0;
           i++;
         }
       }
    }
}

int main()
{
   char text[100], pattern[100];
  int position;

  printf("\n Enter text: ");
  gets(text);

  printf("\n Enter pattern: ");
  gets(pattern);


   position=KMPSearch(pattern, text);
   if(position==-1)
       printf("\n Not found");
   return 0;
}
```

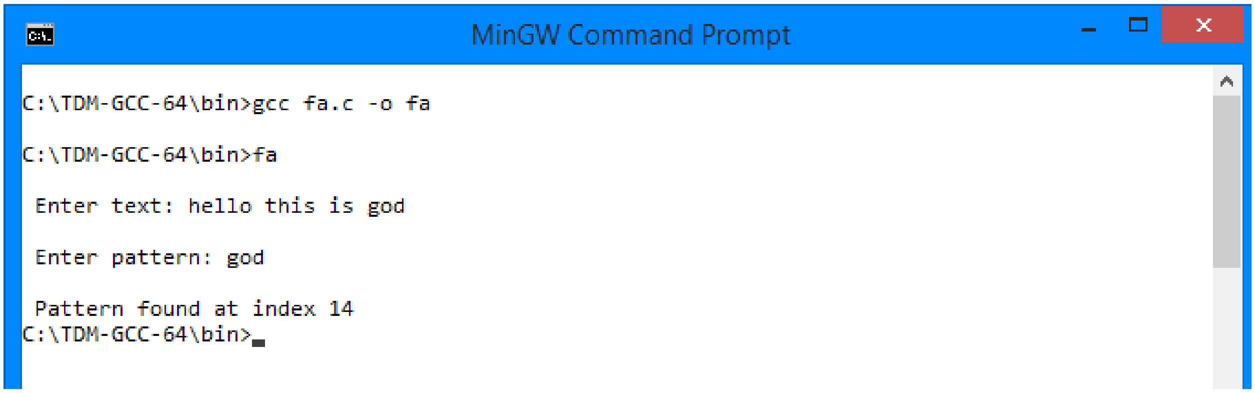


```
C:\TDM-GCC-64\bin>kmp

 Enter text: hello people this is God

 Enter pattern: this
Found pattern at index 13
```

22. String matching by automata

```
#include<stdio.h>
#include<string.h>
#define NO_OF_CHARS 256

int getNextState(char *pattern, int M, int state, int x)
{
    if (state < M && x == pattern[state])
        return state+1;

    int ns, i;
    for (ns = state; ns > 0; ns--)
    {
        if(pattern[ns-1] == x)
        {
            for(i = 0; i < ns-1; i++)
            {
                if (pattern[i] != pattern[state-ns+1+i])
                    break;
            }
            if (i == ns-1)
                return ns;
        }
    }

    return 0;
}

void TransitionFunction(char *pat, int M, int Transition[][NO_OF_CHARS])
{
    int state, x;
    for (state = 0; state <= M; ++state)
        for (x = 0; x < NO_OF_CHARS; ++x)
           Transition[state][x] = getNextState(pat, M,  state, x);
}

void search(char *pattern, char *text)
{
    int M = strlen(pattern);
    int N = strlen(text);

    int Transition[M+1][NO_OF_CHARS];

    TransitionFunction(pattern, M, Transition);

    int i, state=0;
    for (i = 0; i < N; i++)
    {
       state = Transition[state][text[i]];
       if (state == M)
       {
         printf ("\n Pattern found at index %d", i-M+1);
       }
    }
}
```

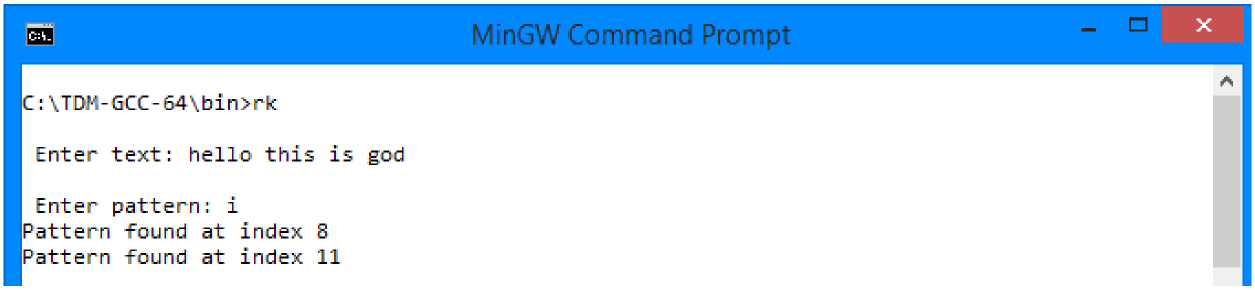
```
int main()
{
          char text[100], pattern[100];

         printf("\n Enter text: ");
         gets(text);

         printf("\n Enter pattern: ");
         gets(pattern);

       search(pattern, text);
   return 0;
}
```



```
C:\TDM-GCC-64\bin>gcc fa.c -o fa

C:\TDM-GCC-64\bin>fa

 Enter text: hello this is god

 Enter pattern: god

 Pattern found at index 14
C:\TDM-GCC-64\bin>
```

23. String matching by Rabin-Karp Algorithm

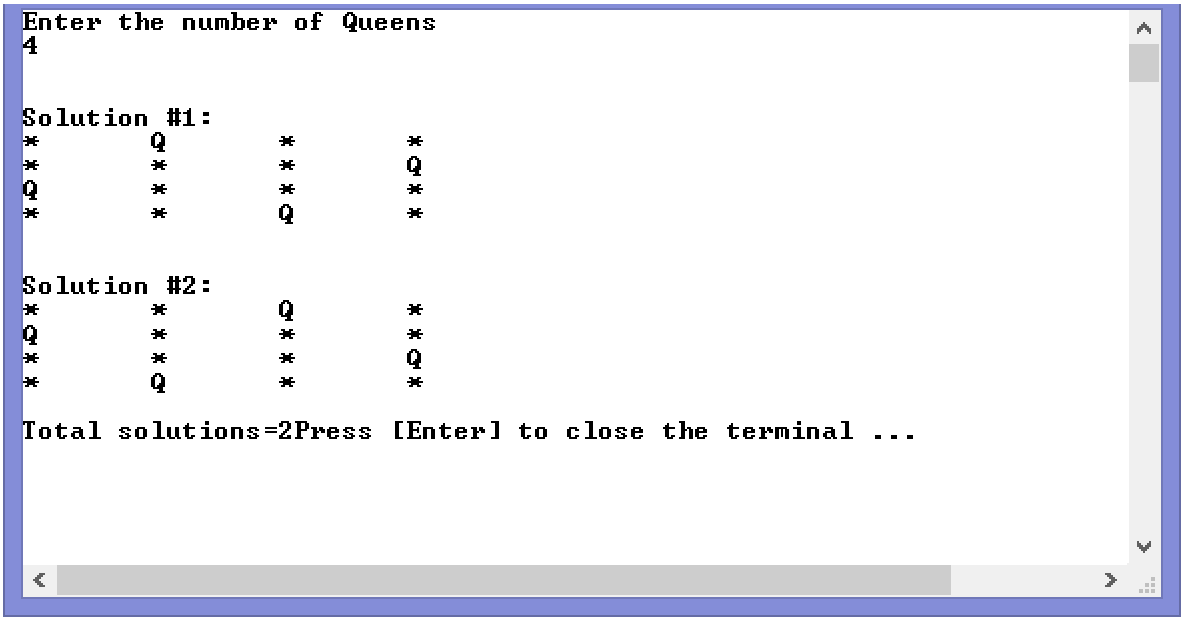
```
#include<stdio.h>
#include<string.h>
#define d 256

void search(char *pat, char *txt, int q)
{
    int M = strlen(pat);
    int N = strlen(txt);
    int i, j;
    int p = 0;
    int t = 0;
    int h = 1;

    for (i = 0; i < M-1; i++)
        h = (h*d)%q;

    for (i = 0; i < M; i++)
    {
        p = (d*p + pat[i])%q;
        t = (d*t + txt[i])%q;
    }
    for (i = 0; i <= N - M; i++)
    {
        if ( p == t )
        {
            for (j = 0; j < M; j++)
            {
                if (txt[i+j] != pat[j])
                    break;
            }
            if (j == M)
            {
                printf("Pattern found at index %d \n", i);
            }
        }
        if ( i < N-M )
        {
            t = (d*(t - txt[i]*h) + txt[i+M])%q;

            if(t < 0)
              t = (t + q);
        }
    }
}

int main()
{
    char text[100], pattern[100];

        printf("\n Enter text: ");
        gets(text);

        printf("\n Enter pattern: ");
        gets(pattern);
    int q = 13;
    search(pattern, text, q);
    return 0;
}
```



```
C:\TDM-GCC-64\bin>rk

 Enter text: hello this is god

 Enter pattern: i
Pattern found at index 8
Pattern found at index 11
```

24. N Queen Problem using Backtracking

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

int a[30],count=0;
int place(int pos)
{
	int i;
	for(i=1;i<pos;i++)
	{
		if((a[i]==a[pos])||((abs(a[i]-a[pos])==abs(i-pos))))
			return 0;
	}
	return 1;
}

void print_sol(int n)
{
	int i,j;
	count++;
	printf("\n\nSolution #%d:\n",count);
	for(i=1;i<=n;i++)
	{
		for(j=1;j<=n;j++)
		{
			if(a[i]==j)
				printf("Q\t");
			else
				printf("*\t");
		}
		printf("\n");
	}
}

void queen(int n)
{
	int k=1;
	a[k]=0;
	while(k!=0)
	{
		a[k]=a[k]+1;
		while((a[k]<=n)&&!place(k))
			a[k]++;
		if(a[k]<=n)
		{
			if(k==n)
				print_sol(n);
			else
			{
				k++;
				a[k]=0;
			}
		}
		else
			k--;
	}
}

void main()
{
	int i,n;
	printf("Enter the number of Queens\n");
	scanf("%d",&n);
	queen(n);
	printf("\nTotal solutions=%d",count);
}
```

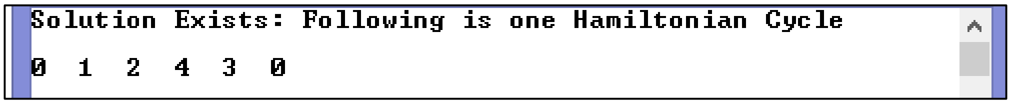


```
Enter the number of Queens
4


Solution #1:
*       Q       *       *
*       *       *       Q
Q       *       *       *
*       *       Q       *


Solution #2:
*       *       Q       *
Q       *       *       *
*       *       *       Q
*       Q       *       *

Total solutions=2Press [Enter] to close the terminal ...
```

25. Hamiltonian path problem

```
#include <stdio.h>
#include <stdlib.h>
#define V 5
#define false 0
#define true 1

void printSolution(int path[]);

int isSafe(int v, int graph[V][V], int path[], int pos)
{
	int i;
if (graph [path[pos-1]][v] == 0)
		return false;
	for (i = 0; i < pos; i++)
		if (path[i] == v)
			return false;
	return true;
}

int hamCycleUtil(int graph[V][V], int path[], int pos)
{
	int v;
	if (pos == V)
	{
		if (graph[ path[pos-1] ][ path[0] ] == 1)
			return true;
		else
			return false;
	}
	for (v = 1; v < V; v++)
	{
		if (isSafe(v, graph, path, pos))
		{
			path[pos] = v;
			if (hamCycleUtil (graph, path, pos+1) == true)
				return true;
			path[pos] = -1;
		}
	}
	return false;
}

int hamCycle(int graph[V][V])
{
	int *path = (int *)malloc(V*sizeof(int));
	int i;
	for (i = 0; i < V; i++)
		path[i] = -1;
	path[0] = 0;
	if (hamCycleUtil(graph, path, 1) == false)
	{
		printf("\nSolution does not exist");
		return false;
	}
```

```
        printSolution(path);
        return true;
}

void printSolution(int path[])
{
        int i;
        printf("Solution Exists:");
        printf(" Following is one Hamiltonian Cycle \n");
        for (i = 0; i < V; i++)
                printf("%d",path[i]);
        printf("%d",path[0]);
}

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

        return 0;
}
```



```
Solution Exists: Following is one Hamiltonian Cycle
0  1  2  4  3  0
```