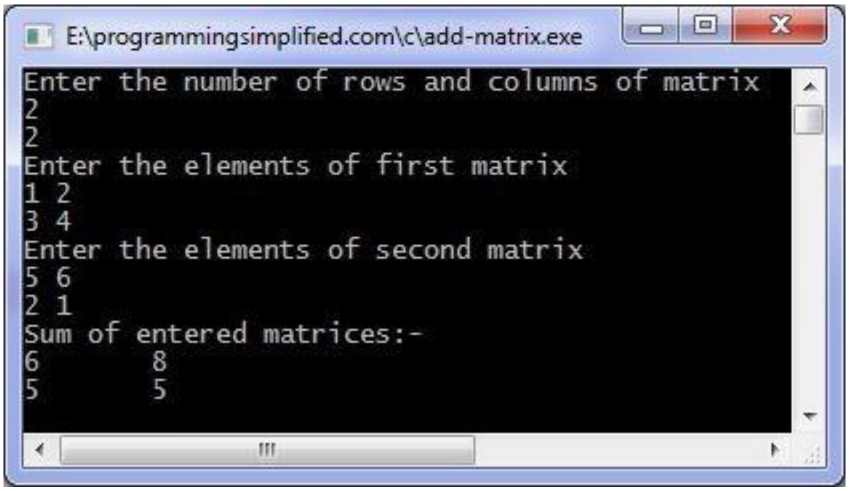
1. Addition Of Two Matrices In C:

```c
#include <stdio.h>

int main()
{
   int m, n, c, d, first[10][10], second[10][10], sum[10][10];

   printf("Enter the number of rows and columns of matrix\n");
   scanf("%d%d", &m, &n);
   printf("Enter the elements of first matrix\n");

      for (c = 0; c < m; c++)
         for (d = 0; d < n; d++)
            scanf("%d", &first[c][d]);

      printf("Enter the elements of second matrix\n");

      for (c = 0; c < m; c++)
         for (d = 0 ; d < n; d++)
            scanf("%d", &second[c][d]);

      printf("Sum of entered matrices:-\n");

      for (c = 0; c < m; c++) {
         for (d = 0 ; d < n; d++) {
            sum[c][d] = first[c][d] + second[c][d];
            printf("%d\t", sum[c][d]);
         }
         printf("\n");
      }

      return 0;
   }
```



2. **Program to find the average of n (n < 10) numbers using arrays**

```
#include <stdio.h>
int main()
{
     int marks[10], i, n, sum = 0, average;
     printf("Enter n: ");
     scanf("%d", &n);
     for(i=0; i<n; ++i)
     {
          printf("Enter number%d: ",i+1);
          scanf("%d", &marks[i]);
          sum += marks[i];
     }
     average =  sum/n;

     printf("Average = %d", average);

     return 0;
}
```

```
Enter n: 5
Enter number1: 45
Enter number2: 35
Enter number3: 38
Enter number4: 31
Enter number5: 49
Average = 39
```

3. C program To Implement Linked List

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

struct node {
  int data;
  struct node *next;
};

struct node *start = NULL;
void insert_at_begin(int);
void insert_at_end(int);
void traverse();
void delete_from_begin();
void delete_from_end();
int count = 0;

int main () {
  int input, data;

  for (;;) {
    printf("1. Insert an element at beginning of linked list.\n");
    printf("2. Insert an element at end of linked list.\n");
    printf("3. Traverse linked list.\n");
    printf("4. Delete element from beginning.\n");
```

```c
    printf("5. Delete element from end.\n");
    printf("6. Exit\n");

    scanf("%d", &input);

    if (input == 1) {
      printf("Enter value of element\n");
      scanf("%d", &data);
      insert_at_begin(data);
    }
    else if (input == 2) {
      printf("Enter value of element\n");
      scanf("%d", &data);
      insert_at_end(data);
    }
    else if (input == 3)
      traverse();
    else if (input == 4)
      delete_from_begin();
    else if (input == 5)
      delete_from_end();
    else if (input == 6)
      break;
    else
      printf("Please enter valid input.\n");
  }

  return 0;
}

void insert_at_begin(int x) {
  struct node *t;

  t = (struct node*)malloc(sizeof(struct node));
  count++;

```

```c
  if (start == NULL) {
    start = t;
    start->data = x;
    start->next = NULL;
    return;
  }

  t->data = x;
  t->next = start;
  start = t;
}

void insert_at_end(int x) {
  struct node *t, *temp;

  t = (struct node*)malloc(sizeof(struct node));
  count++;

  if (start == NULL) {
    start = t;
    start->data = x;
    start->next = NULL;
    return;
  }

  temp = start;

  while (temp->next != NULL)
    temp = temp->next;

  temp->next = t;
  t->data    = x;
  t->next    = NULL;
}

void traverse() {
```

```
    struct node *t;

    t = start;

    if (t == NULL) {
        printf("Linked list is empty.\n");
        return;
    }

    printf("There are %d elements in linked list.\n", count);

    while (t->next != NULL) {
        printf("%d\n", t->data);
        t = t->next;
    }
    printf("%d\n", t->data);
}

void delete_from_begin() {
    struct node *t;
    int n;

    if (start == NULL) {
        printf("Linked list is already empty.\n");
        return;
    }

    n = start->data;
    t = start->next;
    free(start);
    start = t;
    count--;

    printf("%d deleted from beginning successfully.\n", n);
}

```

```
void delete_from_end() {
  struct node *t, *u;
  int n;

  if (start == NULL) {
    printf("Linked list is already empty.\n");
    return;
  }

  count--;

  if (start->next == NULL) {
    n = start->data;
    free(start);
    start = NULL;
    printf("%d deleted from end successfully.\n", n);
    return;
  }

  t = start;

  while (t->next != NULL) {
    u = t;
    t = t->next;
  }

  n = t->data;
  u->next = NULL;
  free(t);

  printf("%d deleted from end successfully.\n", n);
}
```

4. Operations On Linked List

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

struct node
{
  int data;
  struct node *next;
};

void display(struct node* head)
{
      struct node *temp = head;
      printf("\n\nList elements are - \n");
      while(temp != NULL)
      {
   printf("%d --->",temp->data);
   temp = temp->next;
      }
}

void insertAtMiddle(struct node *head, int position, int value) {
    struct node *temp = head;
    struct node *newNode;
    newNode = malloc(sizeof(struct node));
    newNode->data = value;

    int i;

    for(i=2; inext != NULL) {
        temp = temp->next;
        }
    }
    newNode->next = temp->next;
    temp->next = newNode;
}
```

```c
void insertAtFront(struct node** headRef, int value) {
    struct node* head = *headRef;

    struct node *newNode;
    newNode = malloc(sizeof(struct node));
    newNode->data = value;
    newNode->next = head;
    head = newNode;

    *headRef = head;
}

void insertAtEnd(struct node* head, int value){
    struct node *newNode;
    newNode = malloc(sizeof(struct node));
    newNode->data = value;
    newNode->next = NULL;

    struct node *temp = head;
    while(temp->next != NULL){
      temp = temp->next;
    }
    temp->next = newNode;
}

void deleteFromFront(struct node** headRef){
    struct node* head =  *headRef;
    head = head->next;
    *headRef = head;
}

void deleteFromEnd(struct node* head){
    struct node* temp = head;
    while(temp->next->next!=NULL){
      temp = temp->next;
    }
```

```
    temp->next = NULL;
}

void deleteFromMiddle(struct node* head, int position){
    struct node* temp = head;
    int i;
    for(i=2; inext != NULL) {
    temp = temp->next;
    }
}

temp->next = temp->next->next;
}

int main() {
  /* Initialize nodes */
  struct node *head;
  struct node *one = NULL;
  struct node *two = NULL;
  struct node *three = NULL;

  /* Allocate memory */
  one = malloc(sizeof(struct node));
  two = malloc(sizeof(struct node));
  three = malloc(sizeof(struct node));

  /* Assign data values */
  one->data = 1;
  two->data = 2;
  three->data = 3;

  /* Connect nodes */
  one->next = two;
  two->next = three;
  three->next = NULL;
```

```
  /* Save address of first node in head */
  head = one;

  display(head); // 1 --->2 --->3 --->

  insertAtFront(&head, 4);
  display(head); // 4 --->1 --->2 --->3 --->

  deleteFromFront(&head);
  display(head); // 1 --->2 --->3 --->

  insertAtEnd(head, 5);
  display(head); // 1 --->2 --->3 --->5 --->

  deleteFromEnd(head);
  display(head); // 1 --->2 --->3 --->

  int position = 3;
  insertAtMiddle(head, position, 10);
  display(head); // 1 --->2 --->10 --->3 --->

  deleteFromMiddle(head, position);
  display(head); // 1 --->2 --->3 --->
}
```

Output:

```
List elements are -
1 --->2 --->3 --->

List elements are -
4 --->1 --->2 --->3 --->

List elements are -
1 --->2 --->3 --->

List elements are -
```

```
1 --->2 --->3 --->5 --->

List elements are -
1 --->2 --->3 --->

List elements are -
1 --->2 --->10 --->3 --->

List elements are -
1 --->2 --->3 --->
```

5. Circular Linked List

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

struct node {
   int data;
   int key;

   struct node *next;
};

struct node *head = NULL;
struct node *current = NULL;

bool isEmpty()  {
   return head == NULL;
}

int length()  {
   int length = 0;

   //if list is empty
   if(head == NULL) {
      return 0;
   }

   current = head->next;
```

```c
   while(current != head) {
      length++;
      current = current->next;
   }

   return length;
}

//insert link at the first location
void insertFirst(int key, int data) {

   //create a link
   struct node *link = (struct node*) malloc(sizeof(struct node));
   link->key = key;
   link->data = data;

   if (isEmpty()) {
      head = link;
      head->next = head;
   } else {
      //point it to old first node
      link->next = head;

      //point first to new first node
      head = link;
   }
}

//delete first item
struct node * deleteFirst() {

   //save reference to first link
   struct node *tempLink = head;

   if(head->next == head) {
      head = NULL;
      return tempLink;
   }

   //mark next to first link as first
   head = head->next;

   //return the deleted link
   return tempLink;
```

```
}

//display the list
void printList() {

   struct node *ptr = head;
   printf("\n[ ");

   //start from the beginning
   if(head != NULL) {

      while(ptr->next != ptr)  {
         printf("(%d,%d) ",ptr->key,ptr->data);
         ptr = ptr->next;
      }
   }

   printf(" ]");
}

void main() {
   insertFirst(1,10);
   insertFirst(2,20);
   insertFirst(3,30);
   insertFirst(4,1);
   insertFirst(5,40);
   insertFirst(6,56);

   printf("Original List: ");

   //print list
   printList();

   while(!isEmpty()) {
      struct node *temp = deleteFirst();
      printf("\nDeleted value:");
      printf("(%d,%d) ",temp->key,temp->data);
   }

   printf("\nList after deleting all items: ");
   printList();
}
```

Output:

```
Original List:
[ (6,56) (5,40) (4,1) (3,30) (2,20) ]
Deleted value:(6,56)
Deleted value:(5,40)
Deleted value:(4,1)
Deleted value:(3,30)
Deleted value:(2,20)
Deleted value:(1,10)
List after deleting all items:
[ ]
```

6.
```
#include <stdio.h>
#include <string.h>
#include <stdlib.h>
#include <stdbool.h>

struct node {
   int data;
   int key;

   struct node *next;
   struct node *prev;
};

//this link always point to first Link
struct node *head = NULL;

//this link always point to last Link
struct node *last = NULL;

struct node *current = NULL;

//is list empty
bool isEmpty() {
   return head == NULL;
}

int length()  {
   int length = 0;
   struct node *current;

   for(current = head; current != NULL; current = current->next){
      length++;
```

```
   }

   return length;
}

//display the list in from first to last
void displayForward() {

   //start from the beginning
   struct node *ptr = head;

   //navigate till the end of the list
   printf("\n[ ");

   while(ptr != NULL) {
      printf("(%d,%d) ",ptr->key,ptr->data);
      ptr = ptr->next;
   }

   printf(" ]");
}

//display the list from last to first
void displayBackward() {

   //start from the last
   struct node *ptr = last;

   //navigate till the start of the list
   printf("\n[ ");

   while(ptr != NULL) {

      //print data
      printf("(%d,%d) ",ptr->key,ptr->data);

      //move to next item
      ptr = ptr ->prev;

   }

}
```

```c
//insert link at the first location
void insertFirst(int key, int data) {

   //create a link
   struct node *link = (struct node*) malloc(sizeof(struct node));
   link->key = key;
   link->data = data;

   if(isEmpty()) {
      //make it the last link
      last = link;
   } else {
      //update first prev link
      head->prev = link;
   }

   //point it to old first link
   link->next = head;

   //point first to new first link
   head = link;
}

//insert link at the last location
void insertLast(int key, int data) {

   //create a link
   struct node *link = (struct node*) malloc(sizeof(struct node));
   link->key = key;
   link->data = data;

   if(isEmpty()) {
      //make it the last link
      last = link;
   } else {
      //make link a new last link
      last->next = link;

      //mark old last node as prev of new link
      link->prev = last;
   }

   //point last to new last node
```

```
   last = link;
}

//delete first item
struct node* deleteFirst() {

   //save reference to first link
   struct node *tempLink = head;

   //if only one link
   if(head->next == NULL){
      last = NULL;
   } else {
      head->next->prev = NULL;
   }

   head = head->next;
   //return the deleted link
   return tempLink;
}

//delete link at the last location

struct node* deleteLast() {
   //save reference to last link
   struct node *tempLink = last;

   //if only one link
   if(head->next == NULL) {
      head = NULL;
   } else {
      last->prev->next = NULL;
   }

   last = last->prev;

   //return the deleted link
   return tempLink;
}

//delete a link with given key

struct node* delete(int key) {
```

```
   //start from the first link
   struct node* current = head;
   struct node* previous = NULL;

   //if list is empty
   if(head == NULL) {
      return NULL;
   }

   //navigate through list
   while(current->key != key) {
      //if it is last node

      if(current->next == NULL) {
         return NULL;
      } else {
         //store reference to current link
         previous = current;

         //move to next link
         current = current->next;
      }
   }

   //found a match, update the link
   if(current == head) {
      //change first to point to next link
      head = head->next;
   } else {
      //bypass the current link
      current->prev->next = current->next;
   }

   if(current == last) {
      //change last to point to prev link
      last = current->prev;
   } else {
      current->next->prev = current->prev;
   }

   return current;
}
```

```
bool insertAfter(int key, int newKey, int data) {
   //start from the first link
   struct node *current = head;

   //if list is empty
   if(head == NULL) {
      return false;
   }

   //navigate through list
   while(current->key != key) {

      //if it is last node
      if(current->next == NULL) {
         return false;
      } else {
         //move to next link
         current = current->next;
      }
   }

   //create a link
   struct node *newLink = (struct node*) malloc(sizeof(struct node));
   newLink->key = newKey;
   newLink->data = data;

   if(current == last) {
      newLink->next = NULL;
      last = newLink;
   } else {
      newLink->next = current->next;
      current->next->prev = newLink;
   }

   newLink->prev = current;
   current->next = newLink;
   return true;
}

void main() {
   insertFirst(1,10);
   insertFirst(2,20);
```

```
   insertFirst(3,30);
   insertFirst(4,1);
   insertFirst(5,40);
   insertFirst(6,56);

   printf("\nList (First to Last): ");
   displayForward();

   printf("\n");
   printf("\nList (Last to first): ");
   displayBackward();

   printf("\nList , after deleting first record: ");
   deleteFirst();
   displayForward();

   printf("\nList , after deleting last record: ");
   deleteLast();
   displayForward();

   printf("\nList , insert after key(4) : ");
   insertAfter(4,7, 13);
   displayForward();

   printf("\nList  , after delete key(4) : ");
   delete(4);
   displayForward();
}
```

Output:

```
List (First to Last):
[ (6,56) (5,40) (4,1) (3,30) (2,20) (1,10) ]

List (Last to first):
[ (1,10) (2,20) (3,30) (4,1) (5,40) (6,56) ]
List , after deleting first record:
[ (5,40) (4,1) (3,30) (2,20) (1,10) ]
List , after deleting last record:
[ (5,40) (4,1) (3,30) (2,20) ]
List , insert after key(4) :
[ (5,40) (4,1) (4,13) (3,30) (2,20) ]
```

```
List , after delete key(4) :
[ (5,40) (4,13) (3,30) (2,20) ]
```

7. Topological Sort Program In C Language

```
#include <stdio.h>
int main(){
    int i,j,k,n,a[10][10],indeg[10],flag[10],count=0;

    printf("Enter the no of vertices:\n");
    scanf("%d",&n);

    printf("Enter the adjacency matrix:\n");
    for(i=0;i<n;i++){
        printf("Enter row %d\n",i+1);
        for(j=0;j<n;j++)
            scanf("%d",&a[i][j]);
    }

    for(i=0;i<n;i++){
        indeg[i]=0;
        flag[i]=0;
    }

    for(i=0;i<n;i++)
        for(j=0;j<n;j++)
            indeg[i]=indeg[i]+a[j][i];

    printf("\nThe topological order is:");

    while(count<n){
        for(k=0;k<n;k++){
            if((indeg[k]==0) && (flag[k]==0)){
                printf("%d ",(k+1));
                flag [k]=1;
            }
```

```
            for(i=0;i<n;i++){
                if(a[i][k]==1)
                    indeg[k]--;
            }
        }

        count++;
    }

    return 0;
}
```

Output:

Enter the no of vertices:

4

Enter the adjacency matrix:

Enter row 1

0 1 1 0

Enter row 2

0 0 0 1

Enter row 3

0 0 0 1

Enter row 4

0 0 0 0

The topological order is:1 2 3 4

8. String Processing & Manipulation In C Language

```
#include <stdio.h>
#include <string.h>
int main(void)
{
  //variable
  char str[100], tmp;
  int i, len, mid;

  //input
  printf("Enter a string: ");
  gets(str);

  //find number of characters
  len = strlen(str);
  mid = len/2;

  //reverse
  for (i = 0; i < mid; i++) {
    tmp = str[len - 1 - i];
    str[len - 1 - i] = str[i];
    str[i] = tmp;
```

```
  }

  //output
  printf("Reversed string: %s\n", str);

  printf("End of code\n");
  return 0;
}
```

Output:

```
Enter a string: Hello World
Reversed string: dlroW olleH
End of code
```

9.Stacks & Queues Program In C Language

i) Stack:

```
#include <stdio.h>

int MAXSIZE = 8;

int stack[8];

int top = -1;

int isempty() {

if(top == -1)

   return 1;
```

```
   else
      return 0;
}
   int isfull() {
if(top == MAXSIZE)
      return 1;
   else
      return 0;
}
int peek() {
   return stack[top];
}
int pop() {
   int data;
if(!isempty()) {
      data = stack[top];
      top = top - 1;
```

```
      return data;
   } else
{
printf("Could not retrieve data, Stack is empty.\n");
   }
}
int push(int data) {
if(!isfull()) {
      top = top + 1;
      stack[top] = data;
   } else {
      printf("Could not insert data, Stack is full.\n");
   }
}
int main() {
   // push items on to the stack
   push(3);
```

```
   push(5);

   push(9);

   push(1);

   push(12);

   push(15);

printf("Element at top of the stack: %d\n" ,peek());

printf("Elements: \n");

// print stack data

   while(!isempty()) {

      int data = pop();

      printf("%d\n",data);

   }

printf("Stack full: %s\n" , isfull()?"true":"false");

printf("Stack empty: %s\n" , isempty()?"true":"false");

   return 0;

}
```

Output:

Element at top of the stack: 15

Elements:

15

12

1

9

5

3

Stack full: false

Stack empty: true

ii) Queue

```
#include <stdio.h>

#include <string.h>

#include <stdlib.h>

#include <stdbool.h>


#define MAX 6
```

```
int intArray[MAX];

int front = 0;

int rear = -1;

int itemCount = 0;


int peek() {

   return intArray[front];

}


bool isEmpty() {

   return itemCount == 0;

}


bool isFull() {

   return itemCount == MAX;

}
```

```
int size() {
   return itemCount;
}

void insert(int data) {

   if(!isFull()) {

      if(rear == MAX-1) {
         rear = -1;
      }

      intArray[++rear] = data;
      itemCount++;
   }
}
```

```
int removeData() {
   int data = intArray[front++];

   if(front == MAX) {
      front = 0;
   }

   itemCount--;
   return data;
}

int main() {
   /* insert 5 items */
   insert(3);
   insert(5);
   insert(9);
```

```
insert(1);
insert(12);

// front : 0
// rear  : 4
// ------------------
// index : 0 1 2 3 4
// ------------------
// queue : 3 5 9 1 12
insert(15);

// front : 0
// rear  : 5
// ---------------------
// index : 0 1 2 3 4  5
// ---------------------
// queue : 3 5 9 1 12 15
```

```
if(isFull()) {
   printf("Queue is full!\n");
}

// remove one item
int num = removeData();

printf("Element removed: %d\n",num);
// front : 1
// rear  : 5
// -------------------
// index : 1 2 3 4  5
// -------------------
// queue : 5 9 1 12 15

// insert more items
```

```
insert(16);

// front : 1
// rear : -1
// ----------------------
// index : 0 1 2 3 4  5
// ----------------------
// queue : 16 5 9 1 12 15

// As queue is full, elements will not be inserted.
insert(17);
insert(18);

// ----------------------
// index : 0 1 2 3 4  5
// ----------------------
// queue : 16 5 9 1 12 15
```

```
    printf("Element at front: %d\n",peek());

    printf("----------------------\n");
    printf("index : 5 4 3 2 1 0\n");
    printf("----------------------\n");
    printf("Queue:  ");

    while(!isEmpty()) {
       int n = removeData();
       printf("%d ",n);
    }
}
```

Output:

Queue is full!

Element removed: 3

Element at front: 5

----

index : 5 4 3 2 1 0

Queue: 5 9 1 12 15 16

10. Sorting & Searching Techniques

i) Sorting

```
/*
 * C program to accept N numbers and arrange them in an ascending order
 */

#include <stdio.h>
void main()
{

    int i, j, a, n, number[30];
    printf("Enter the value of N \n");
```

```
scanf("%d", &n);



printf("Enter the numbers \n");

for (i = 0; i < n; ++i)

    scanf("%d", &number[i]);



for (i = 0; i < n; ++i)

{



    for (j = i + 1; j < n; ++j)

    {



        if (number[i] > number[j])

        {
```

```
                a = number[i];

                number[i] = number[j];

                number[j] = a;

               }



            }



        }

    printf("The numbers arranged in ascending order are given below \n");

        for (i = 0; i < n; ++i)

            printf("%d\n", number[i]);

 }
```

Output:

Enter the value of N:

6

Enter the numbers

3

78

90

456

780

200

The numbers arranged in ascending order are given below

3

78

90

200

456

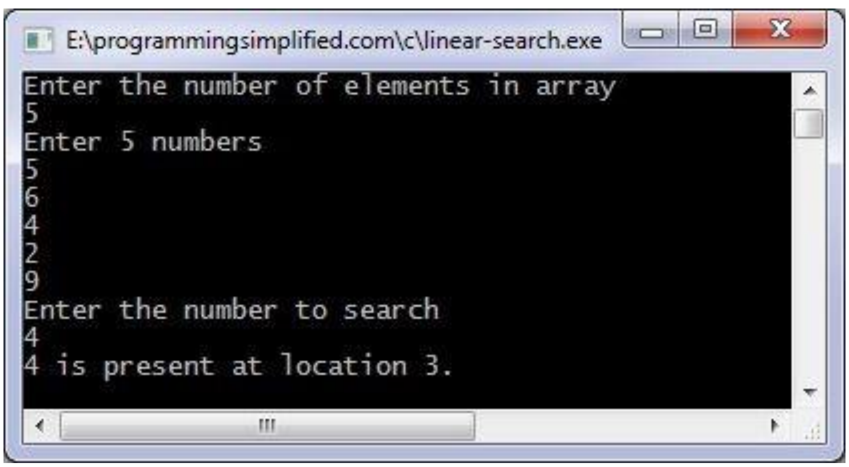
780

ii) Searching

```
#include <stdio.h>

int main()
{
  int array[100], search, c, n;

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

  printf("Enter %d integer(s)\n", n);

for (c = 0; c < n; c++)
    scanf("%d", &array[c]);

  printf("Enter a number to search\n");
  scanf("%d", &search);

for (c = 0; c < n; c++)
  {
    if (array[c] == search)     /* If required element is found */
    {
      printf("%d is present at location %d.\n", search, c+1);
      break;
    }
```

```
}
if (c == n)
  printf("%d isn't present in the array.\n", search);

return 0;
}
```

Output:



11. Dynamic Programming

```
#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 items:3

Enter value and weight of items:

100 20

50 10

150 30

Enter size of knapsack:50

250
```

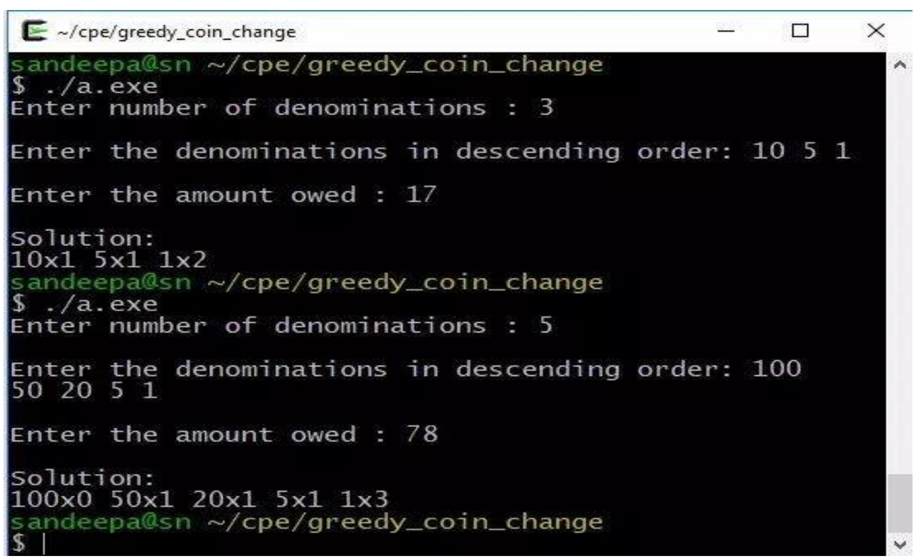
12. Greedy Algorithm In C Language

```
#include <stdio.h>

int main () {

            int num_denominations, coin_list[100], use_these[100], i, owed;
```

```
printf("Enter number of denominations : ");

scanf("%d", &num_denominations);



printf("\nEnter the denominations in descending order: ");



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

        scanf("%d", &coin_list[i]);

        // use_these[i] = 0;

}



printf("\nEnter the amount owed : ");

scanf("%d", &owed);

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

        use_these[i] = owed / coin_list[i];
```

```
        owed %= coin_list[i];

    }

    printf("\nSolution: \n");

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

        printf("%dx%d ", coin_list[i], use_these[i]);

    }

}
```

Output:



13. String Matching Program In C Language

```
#include<stdio.h>

#include<conio.h>



int length(char x[])

{

    int i;

    for(i=0;x[i]!='\0';i++)

    {}

    return i;

}

void main()

{

        char s[20],p[20];
```

```
int i,l,count=0;

clrscr();



printf("\n enter Your String = ");

scanf("%s",s);

printf("enter the string to be matched = ");

scanf("%s",p );

l=length(p);



        for(i=0;s[i]!='\0';i++)

        {

          if(s[i]==p[count] )

                    count++;

        else

        {
```

```
                count=0;
          }
           if ( count == l )
                {
                      printf("Substring %s found in the given string",p);
                 break;
                }
          }if(count!=l)
          printf("not found");
getch();
}
```

Output:

```
 enter Your String   =  1101010101000011
enter the string to be matched = 1010
Substring 1010 found in the given string
 enter Your String   =  11001010101010101011010101001O1
enter the string to be matched = 101
Substring 101 found in the given string
```

14. Divide & Conquer Program In C language

```
#include <stdio.h>



#define max 10



int a[11] = { 10, 14, 19, 26, 27, 31, 33, 35, 42, 44, 0 };

int b[10];



void merging(int low, int mid, int high) {

   int l1, l2, i;



   for(l1 = low, l2 = mid + 1, i = low; l1 <= mid && l2 <= high; i++) {

      if(a[l1] <= a[l2])

         b[i] = a[l1++];

      else
```

```
        b[i] = a[l2++];
    }

    while(l1 <= mid)
        b[i++] = a[l1++];

    while(l2 <= high)
        b[i++] = a[l2++];

    for(i = low; i <= high; i++)
        a[i] = b[i];
}

void sort(int low, int high) {
    int mid;
```

```
    if(low < high) {
      mid = (low + high) / 2;
      sort(low, mid);
      sort(mid+1, high);
      merging(low, mid, high);
    } else {
      return;
    }
}

int main() {
    int i;

    printf("List before sorting\n");
```

```
   for(i = 0; i <= max; i++)
      printf("%d ", a[i]);

   sort(0, max);

   printf("\nList after sorting\n");

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

Output:

List before sorting

10 14 19 26 27 31 33 35 42 44 0

List after sorting

0 10 14 19 26 27 31 33 35 42 44

15. Disjoint sets Program In C Language

```
// A union-find algorithm to detect cycle in a graph

#include <stdio.h>

#include <stdlib.h>

#include <string.h>



// a structure to represent an edge in graph

struct Edge

{

    int src, dest;

};



// a structure to represent a graph

struct Graph

{
```

```
    // V-> Number of vertices, E-> Number of edges

    int V, E;



    // graph is represented as an array of edges

    struct Edge* edge;

};



// Creates a graph with V vertices and E edges

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;
}

// A utility function to find the subset of an element i
int find(int parent[], int i)
{
    if (parent[i] == -1)
        return i;
    return find(parent, parent[i]);
}

// A utility function to do union of two subsets
```

```
void Union(int parent[], int x, int y)

{

    int xset = find(parent, x);

    int yset = find(parent, y);

    if(xset!=yset){

       parent[xset] = yset;

    }

}



// The main function to check whether a given graph contains

// cycle or not

int isCycle( struct Graph* graph )

{

    // Allocate memory for creating V subsets

    int *parent = (int*) malloc( graph->V * sizeof(int) );
```

```
// Initialize all subsets as single element sets
memset(parent, -1, sizeof(int) * graph->V);


// Iterate through all edges of graph, find subset of both
// vertices of every edge, if both subsets are same, then
// there is cycle in graph.
for(int i = 0; i < graph->E; ++i)
{
    int x = find(parent, graph->edge[i].src);
    int y = find(parent, graph->edge[i].dest);


    if (x == y)
        return 1;
```

```
        Union(parent, x, y);
    }
    return 0;
}

// Driver program to test above functions
int main()
{
    /* Let us create following graph
         0
        |  \
        |    \
        1-----2 */
    int V = 3, E = 3;
    struct Graph* graph = createGraph(V, E);
```

```
// add edge 0-1

graph->edge[0].src = 0;

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



// add edge 1-2

graph->edge[1].src = 1;

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



// add edge 0-2

graph->edge[2].src = 0;

graph->edge[2].dest = 2;



if (isCycle(graph))

    printf( "graph contains cycle" );
```

```
    else
        printf( "graph doesn't contain cycle" );

    return 0;
}
```

Output:

graph contains cycle

16. Computational Geometry

```
#include <bits/stdc++.h>
using namespace std;

struct Point
{
    int x, y;
};
```

```
// To find orientation of ordered triplet (p, q, r).
// The function returns following values
// 0 --> p, q and r are colinear
// 1 --> Clockwise
// 2 --> Counterclockwise
int orientation(Point p, Point q, Point r)
{
    int val = (q.y - p.y) * (r.x - q.x) -
              (q.x - p.x) * (r.y - q.y);

    if (val == 0) return 0; // colinear
    return (val > 0)? 1: 2; // clock or counterclock wise
}
```

```
// Prints convex hull of a set of n points.

void convexHull(Point points[], int n)

{

    // There must be at least 3 points

    if (n < 3) return;



    // Initialize Result

    vector<Point> hull;



    // Find the leftmost point

    int l = 0;

    for (int i = 1; i < n; i++)

        if (points[i].x < points[l].x)

            l = i;
```

```
// Start from leftmost point, keep moving counterclockwise
// until reach the start point again. This loop runs O(h)
// times where h is number of points in result or output.
int p = l, q;
do
{
    // Add current point to result
    hull.push_back(points[p]);

    // Search for a point 'q' such that orientation(p, x,
    // q) is counterclockwise for all points 'x'. The idea
    // is to keep track of last visited most counterclock-
    // wise point in q. If any point 'i' is more counterclock-
    // wise than q, then update q.
    q = (p+1)%n;
```

```
    for (int i = 0; i < n; i++)
    {
       // If i is more counterclockwise than current q, then
       // update q
       if (orientation(points[p], points[i], points[q]) == 2)
           q = i;
    }

    // Now q is the most counterclockwise with respect to p
    // Set p as q for next iteration, so that q is added to
    // result 'hull'
    p = q;

} while (p != l); // While we don't come to first point
```

```
    // Print Result
    for (int i = 0; i < hull.size(); i++)
        cout << "(" << hull[i].x << ", "
             << hull[i].y << ")\n";
}
  // Driver program to test above functions
int main()
{
    Point points[] = {{0, 3}, {2, 2}, {1, 1}, {2, 1},
                      {3, 0}, {0, 0}, {3, 3}};
    int n = sizeof(points)/sizeof(points[0]);
    convexHull(points, n);
    return 0;
}
```

Output:

The output is points of the convex hull.

(0, 3)

(0, 0)

(3, 0)

(3, 3)

17. // Program to print BFS traversal from a given

```
// source vertex. BFS(int s) traverses vertices

// reachable from s.

#include<iostream>

#include <list>



using namespace std;



// This class represents a directed graph using

// adjacency list representation
```

```
class Graph

{

    int V;    // No. of vertices



    // Pointer to an array containing adjacency

    // lists

    list<int> *adj;

public:

    Graph(int V); // Constructor



    // function to add an edge to graph

    void addEdge(int v, int w);



    // prints BFS traversal from a given source s

    void BFS(int s);
```

```
};

Graph::Graph(int V)
{
    this->V = V;
    adj = new list<int>[V];
}

void Graph::addEdge(int v, int w)
{
    adj[v].push_back(w); // Add w to v’s list.
}

void Graph::BFS(int s)
{
```

```
// Mark all the vertices as not visited

bool *visited = new bool[V];

for(int i = 0; i < V; i++)

    visited[i] = false;



// Create a queue for BFS

list<int> queue;



// Mark the current node as visited and enqueue it

visited[s] = true;

queue.push_back(s);



// 'i' will be used to get all adjacent

// vertices of a vertex

list<int>::iterator i;
```

```
while(!queue.empty())
{
    // Dequeue a vertex from queue and print it
    s = queue.front();
    cout << s << " ";
    queue.pop_front();

    // Get all adjacent vertices of the dequeued
    // vertex s. If a adjacent has not been visited,
    // then mark it visited and enqueue it
    for (i = adj[s].begin(); i != adj[s].end(); ++i)
    {
        if (!visited[*i])
        {
```

```
                visited[*i] = true;

                queue.push_back(*i);

            }

        }

    }

}



// Driver program to test methods of graph class

int main()

{

    // Create a graph given in the above diagram

    Graph g(4);

    g.addEdge(0, 1);

    g.addEdge(0, 2);

    g.addEdge(1, 2);
```

```
    g.addEdge(2, 0);

    g.addEdge(2, 3);

    g.addEdge(3, 3);



    cout << "Following is Breadth First Traversal "

         << "(starting from vertex 2) \n";

    g.BFS(2);



    return 0;

}
```

Output

Following is Breadth First Traversal (starting from vertex 2)

2 0 3 1

18.
```
#include <stdio.h>

#include <stdlib.h>



struct node {

    int data;

    struct node* left;

    struct node* right;

};



struct node* createNode(value){

    struct node* newNode = malloc(sizeof(struct node));

    newNode->data = value;

    newNode->left = NULL;

    newNode->right = NULL;
```

```
    return newNode;
}

struct node* insertLeft(struct node *root, int value) {
    root->left = createNode(value);
    return root->left;
}

struct node* insertRight(struct node *root, int value){
    root->right = createNode(value);
    return root->right;
}

int main(){
```

```
    struct node *root = createNode(1);

    insertLeft(root, 2);

    insertRight(root, 3);



    printf("The elements of tree are %d %d %d", root->data, root->left->data, root->right->data);

}
```

Output - 1 2 3

19. **Dijkstra’s Algorithm**

```
#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;

    //pred[] stores the predecessor of each node
    //count gives the number of nodes seen so far
    //create the cost matrix
    for(i=0;i<n;i++)
        for(j=0;j<n;j++)
            if(G[i][j]==0)
```

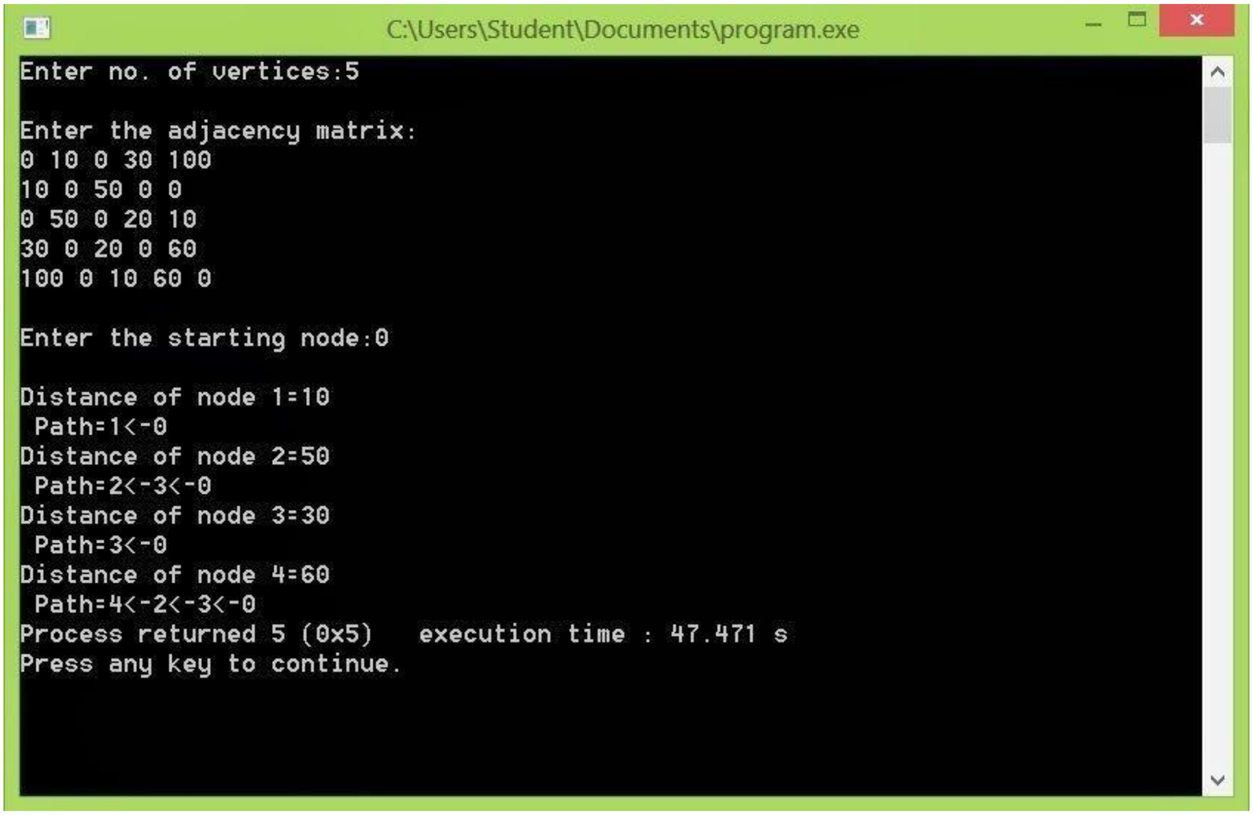
```
            cost[i][j]=INFINITY;
        else
            cost[i][j]=G[i][j];


//initialize pred[],distance[] and visited[]
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;

    //nextnode gives the node at minimum distance
    for(i=0;i<n;i++)
        if(distance[i]<mindistance&&!visited[i])
        {
            mindistance=distance[i];
            nextnode=i;
        }

        //check if a better path exists through nextnode
        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++;
}

//print the path and distance of each node
for(i=0;i<n;i++)
    if(i!=startnode)
    {
        printf("\nDistance of node%d=%d",i,distance[i]);
```

```
            printf("\nPath=%d",i);

            j=i;
            do
            {
                j=pred[j];
                printf("<-%d",j);
            }while(j!=startnode);
        }
    }
```

Output:



20. Prims Algorithm

```
// A C / C++ program for Prim's Minimum

// Spanning Tree (MST) algorithm. The program is

// for adjacency matrix representation of the graph

#include <stdio.h>

#include <limits.h>
```

```
#include<stdbool.h>

// Number of vertices in the graph

#define V 5



// A utility function to find the vertex with

// minimum key value, from the set of vertices

// not yet included in MST

int minKey(int key[], bool mstSet[])

{

// Initialize min value

int min = INT_MAX, min_index;



for (int v = 0; v < V; v++)

    if (mstSet[v] == false && key[v] < min)

        min = key[v], min_index = v;
```

```
return min_index;

}



// A utility function to print the

// constructed MST stored in parent[]

int printMST(int parent[], int n, int graph[V][V])

{

printf("Edge \tWeight\n");

for (int i = 1; i < V; i++)

    printf("%d - %d \t%d \n", parent[i], i, graph[i][parent[i]]);

}



// Function to construct and print MST for

// a graph represented using adjacency
```

```
// matrix representation
void primMST(int graph[V][V])
{
    // Array to store constructed MST
    int parent[V];
    // Key values used to pick minimum weight edge in cut
    int key[V];
    // To represent set of vertices not yet included in MST
    bool mstSet[V];

    // Initialize all keys as INFINITE
    for (int i = 0; i < V; i++)
        key[i] = INT_MAX, mstSet[i] = false;

    // Always include first 1st vertex in MST.
```

```
// Make key 0 so that this vertex is picked as first vertex.

key[0] = 0;

parent[0] = -1; // First node is always root of MST



// The MST will have V vertices

for (int count = 0; count < V-1; count++)

{

    // Pick the minimum key vertex from the

    // set of vertices not yet included in MST

    int u = minKey(key, mstSet);



    // Add the picked vertex to the MST Set

    mstSet[u] = true;



    // Update key value and parent index of
```

```
        // the adjacent vertices of the picked vertex.

        // Consider only those vertices which are not

        // yet included in MST

        for (int v = 0; v < V; v++)



        // graph[u][v] is non zero only for adjacent vertices of m

        // mstSet[v] is false for vertices not yet included in MST

        // Update the key only if graph[u][v] is smaller than key[v]

        if (graph[u][v] && mstSet[v] == false && graph[u][v] < key[v])

            parent[v] = u, key[v] = graph[u][v];

    }



    // print the constructed MST

    printMST(parent, V, graph);

}
```

```
// driver program to test above function

int main()

{

/* Let us create the following graph

        2 3

    (0)--(1)--(2)

    | / \ |

    6| 8/ \5 |7

    | /     \ |

    (3)-------(4)

            9         */

int graph[V][V] = {{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}};

    // Print the solution
    primMST(graph);

    return 0;
}
```

Output:

```
Edge   Weight
0 - 1    2
1 - 2    3
0 - 3    6
1 - 4    5
```