

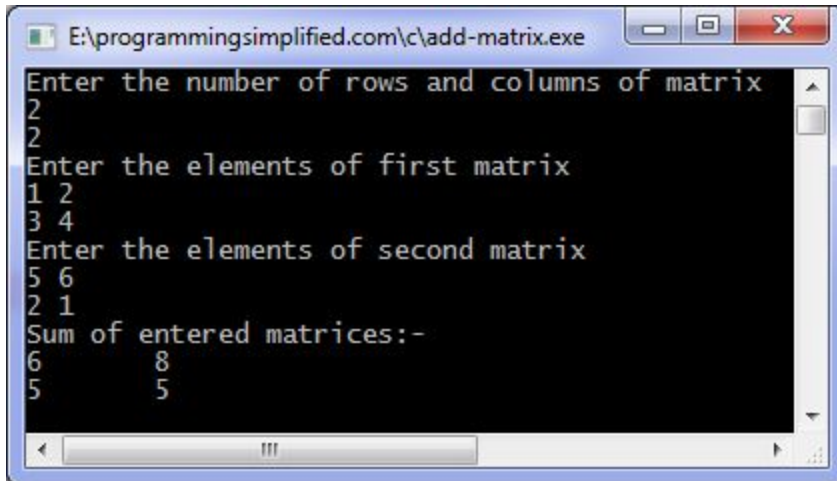
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1. Addition Of Two Matrices In C:

```
1. #include <stdio.h>
2.
3. int main()
4. {
5.     int m, n, c, d, first[10][10], second[10][10], sum[10][10];
6.
7.     printf("Enter the number of rows and columns of matrix\n");
8.     scanf("%d%d", &m, &n);
9.     printf("Enter the elements of first matrix\n");
10.
11.     for (c = 0; c < m; c++)
12.         for (d = 0; d < n; d++)
13.             scanf("%d", &first[c][d]);
14.
15.     printf("Enter the elements of second matrix\n");
16.
17.     for (c = 0; c < m; c++)
18.         for (d = 0; d < n; d++)
19.             scanf("%d", &second[c][d]);
20.
21.     printf("Sum of entered matrices:-\n");
22.
23.     for (c = 0; c < m; c++) {
24.         for (d = 0; d < n; d++) {
25.             sum[c][d] = first[c][d] + second[c][d];
26.             printf("%d\t", sum[c][d]);
27.         }
28.         printf("\n");
29.     }
30.
31.     return 0;
32. }
```

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Output:



```
E:\programmingsimplified.com\c\add-matrix.exe
Enter the number of rows and columns of matrix
2
2
Enter the elements of first matrix
1 2
3 4
Enter the elements of second matrix
5 6
2 1
Sum of entered matrices:-
6      8
5      5
```

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;
}
```

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Output:

```
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

```
1. #include <stdio.h>
2. #include <stdlib.h>
3.
4. struct node {
5.     int data;
6.     struct node *next;
7. };
8.
9. struct node *start = NULL;
10. void insert_at_begin(int);
11. void insert_at_end(int);
12. void traverse();
13. void delete_from_begin();
14. void delete_from_end();
15. int count = 0;
16.
17. int main () {
18.     int input, data;
19.
20.     for (;;) {
21.         printf("1. Insert an element at beginning of linked list.\n");
22.         printf("2. Insert an element at end of linked list.\n");
23.         printf("3. Traverse linked list.\n");
24.         printf("4. Delete element from beginning.\n");
```

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```
25.     printf("5. Delete element from end.\n");
26.     printf("6. Exit\n");
27.
28.     scanf("%d", &input);
29.
30.     if (input == 1) {
31.         printf("Enter value of element\n");
32.         scanf("%d", &data);
33.         insert_at_begin(data);
34.     }
35.     else if (input == 2) {
36.         printf("Enter value of element\n");
37.         scanf("%d", &data);
38.         insert_at_end(data);
39.     }
40.     else if (input == 3)
41.         traverse();
42.     else if (input == 4)
43.         delete_from_begin();
44.     else if (input == 5)
45.         delete_from_end();
46.     else if (input == 6)
47.         break;
48.     else
49.         printf("Please enter valid input.\n");
50. }
51.
52. return 0;
53. }
54.
55. void insert_at_begin(int x) {
56.     struct node *t;
57.
58.     t = (struct node*)malloc(sizeof(struct node));
59.     count++;
60.
```

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```
61.     if (start == NULL) {
62.         start = t;
63.         start->data = x;
64.         start->next = NULL;
65.         return;
66.     }
67.
68.     t->data = x;
69.     t->next = start;
70.     start = t;
71. }
72.
73. void insert_at_end(int x) {
74.     struct node *t, *temp;
75.
76.     t = (struct node*)malloc(sizeof(struct node));
77.     count++;
78.
79.     if (start == NULL) {
80.         start = t;
81.         start->data = x;
82.         start->next = NULL;
83.         return;
84.     }
85.
86.     temp = start;
87.
88.     while (temp->next != NULL)
89.         temp = temp->next;
90.
91.     temp->next = t;
92.     t->data = x;
93.     t->next = NULL;
94. }
95.
96. void traverse() {
```

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```
97.    struct node *t;
98.
99.    t = start;
100.
101.    if (t == NULL) {
102.        printf("Linked list is empty.\n");
103.        return;
104.    }
105.
106.    printf("There are %d elements in linked list.\n", count);
107.
108.    while (t->next != NULL) {
109.        printf("%d\n", t->data);
110.        t = t->next;
111.    }
112.    printf("%d\n", t->data);
113. }
114.
115. void delete_from_begin() {
116.    struct node *t;
117.    int n;
118.
119.    if (start == NULL) {
120.        printf("Linked list is already empty.\n");
121.        return;
122.    }
123.
124.    n = start->data;
125.    t = start->next;
126.    free(start);
127.    start = t;
128.    count--;
129.
130.    printf("%d deleted from beginning successfully.\n", n);
131. }
132.
```

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```
133. void delete_from_end() {
134.     struct node *t, *u;
135.     int n;
136.
137.     if (start == NULL) {
138.         printf("Linked list is already empty.\n");
139.         return;
140.     }
141.
142.     count--;
143.
144.     if (start->next == NULL) {
145.         n = start->data;
146.         free(start);
147.         start = NULL;
148.         printf("%d deleted from end successfully.\n", n);
149.         return;
150.     }
151.
152.     t = start;
153.
154.     while (t->next != NULL) {
155.         u = t;
156.         t = t->next;
157.     }
158.
159.     n = t->data;
160.     u->next = NULL;
161.     free(t);
162.
163.     printf("%d deleted from end successfully.\n", n);
164. }
```

4. Operations On Linked List

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```
#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;
}
```


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```
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;
    }
}
```

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```
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;
}
```

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```

/* 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 -

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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;
```

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```
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;
}
```

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```
}  
  
//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:

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```
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++;
    }
}
```

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```
}

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;
    }
}
```


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```
//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
```

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```

    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) {

```

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```
//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;
}
```

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```
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);
}
```

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```
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) ]
```

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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;
                }
            }
        }
    }
}
```

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```
        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

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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;
    }
}
```


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```
}  
  
//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;
```

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```
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;
```

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```
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);
```

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```
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:

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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
```

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```
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;
```

```
}
```

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```
int size() {  
  
    return itemCount;  
  
}  
  
void insert(int data) {  
  
    if(!isFull()) {  
  
        if(rear == MAX-1) {  
  
            rear = -1;  
  
        }  
  
        intArray[++rear] = data;  
  
        itemCount++;  
  
    }  
  
}
```

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```
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);  
}
```


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```
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
```

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```
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
```

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```
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
```

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```
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

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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");
```

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```
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])
```

```
{
```

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```
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

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Enter the numbers

3

78

90

456

780

200

The numbers arranged in ascending order are given below

3

78

90

200

456

780

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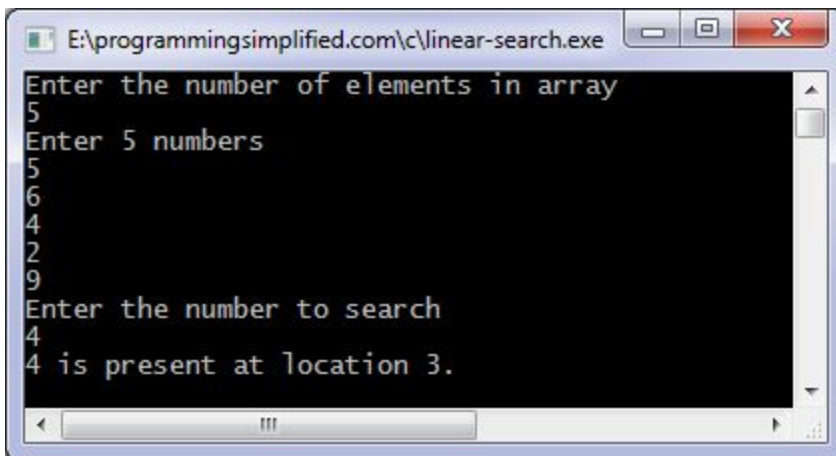
ii) Searching

```
1. #include <stdio.h>
2.
3. int main()
4. {
5.     int array[100], search, c, n;
6.
7.     printf("Enter number of elements in array\n");
8.     scanf("%d", &n);
9.
10.    printf("Enter %d integer(s)\n", n);
11.
12.    for (c = 0; c < n; c++)
13.        scanf("%d", &array[c]);
14.
15.    printf("Enter a number to search\n");
16.    scanf("%d", &search);
17.
18.    for (c = 0; c < n; c++)
19.    {
20.        if (array[c] == search) /* If required element is found */
21.        {
22.            printf("%d is present at location %d.\n", search, c+1);
23.            break;
24.        }
```

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```
25. }  
26. if (c == n)  
27.     printf("%d isn't present in the array.\n", search);  
28.  
29. return 0;  
30. }
```

Output:



```
E:\programmingsimplified.com\c\linear-search.exe  
Enter the number of elements in array  
5  
Enter 5 numbers  
5  
6  
4  
2  
9  
Enter the number to search  
4  
4 is present at location 3.
```

11. Dynamic Programming

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

```
int max(int a, int b) { return (a > b)? a : b; }
```

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```
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];
```

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```
    }  
  
}  
  
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);
```

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```
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;
```

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```
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];
```

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```
        owed %= coin_list[i];

    }

    printf("\nSolution: \n");

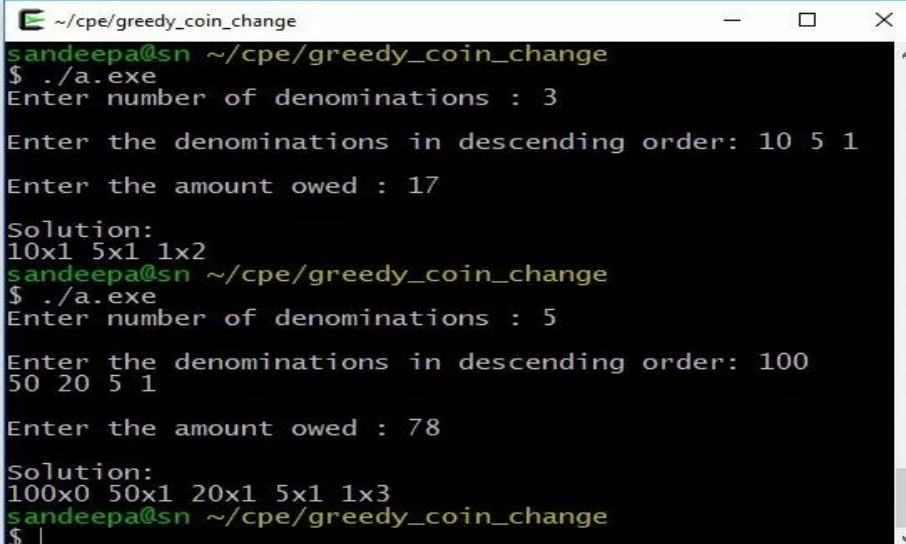
    for(i=0; i < num_denominations; i++) {

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

    }

}
```

Output:



```
~/cpe/greedy_coin_change
sandeepa@sn ~/cpe/greedy_coin_change
$ ./a.exe
Enter number of denominations : 3
Enter the denominations in descending order: 10 5 1
Enter the amount owed : 17

Solution:
10x1 5x1 1x2
sandeepa@sn ~/cpe/greedy_coin_change
$ ./a.exe
Enter number of denominations : 5
Enter the denominations in descending order: 100
50 20 5 1
Enter the amount owed : 78

Solution:
100x0 50x1 20x1 5x1 1x3
sandeepa@sn ~/cpe/greedy_coin_change
$
```

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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];
```


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```
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
```

```
{
```

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```
        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 = 110101010100011
enter the string to be matched = 1010
Substring 1010 found in the given string
enter Your String = 1100101010101010101101010100101
enter the string to be matched = 101
Substring 101 found in the given string
```

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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
```

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```
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;
```

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```
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");
```

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```
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

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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
```

```
{
```

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```
// 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;
```


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```
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
```

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```
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) );
```

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```
// 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;
```

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```
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);
```

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```
// 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" );
```

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```
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;
```

```
};
```

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```
// 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

}
```

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```
// 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;
```


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```
// 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;
```

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```
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
```

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```
// 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:

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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
```

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```
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);
```

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```
};
```

```
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)
```

```
{
```

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```
// 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;
```

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```
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])  
  
        {
```


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```
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);
```

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```
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

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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;

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```
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(){
```

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```
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);
```

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```
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);
```

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```
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)
```

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```
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;
```


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```
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;
```

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```
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]);
```

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

j=i;

do

{

    j=pred[j];

    printf("<-%d",j);

}while(j!=startnode);

}

}
```

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Output:

```
C:\Users\Student\Documents\program.exe
Enter no. of vertices:5
Enter the adjacency matrix:
0 10 0 30 100
10 0 50 0 0
0 50 0 20 10
30 0 20 0 60
100 0 10 60 0
Enter the starting node:0
Distance of node 1=10
  Path=1<-0
Distance of node 2=50
  Path=2<-3<-0
Distance of node 3=30
  Path=3<-0
Distance of node 4=60
  Path=4<-2<-3<-0
Process returned 5 (0x5)   execution time : 47.471 s
Press any key to continue.
```

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>
```

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```
#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;
```

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```
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
```

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```
// 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.
```

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```
// 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
```


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```
// 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 u

    // 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);

}
```

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```
// 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},
```

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```
{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