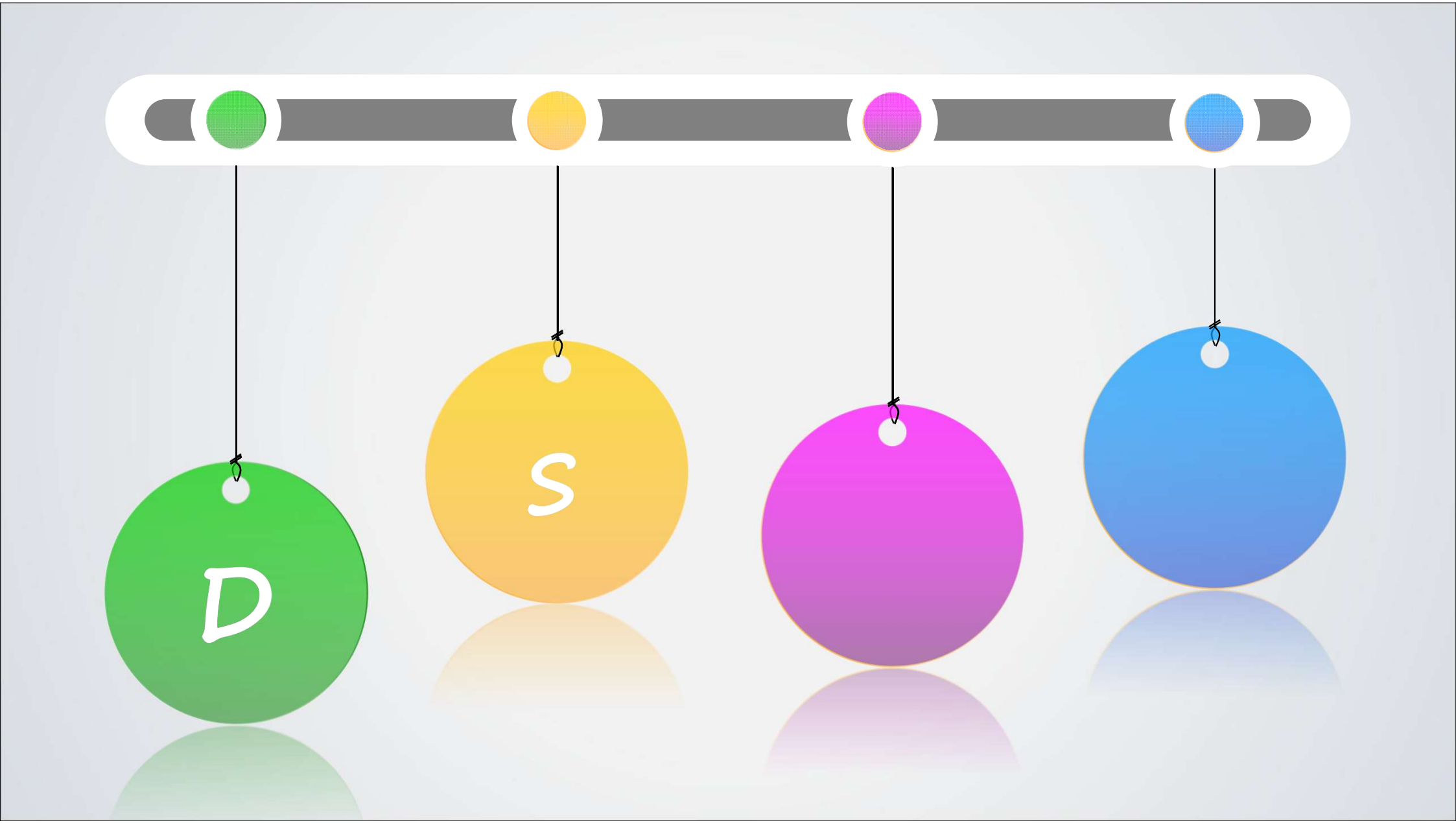
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Queues: Introduction

02 TOPIC

Array and Linked List representation of Queues

03 TOPIC

Operations on Queue using Array

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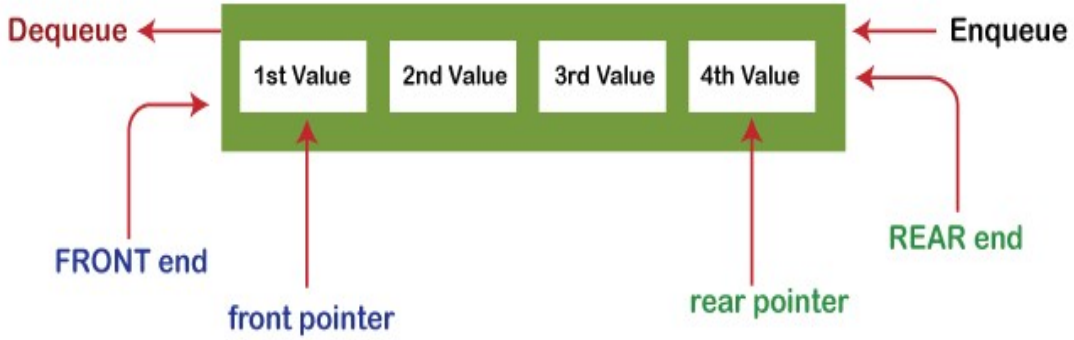
Deque using array

Queue

- Queue is a linear data structure, in which the **element is inserted from** one end called the **REAR**(also called tail), and the **removal of an element takes place** from the other end called as **FRONT**(also called head).



- This makes queue as FIFO(First in First Out) data structure, which means that **element inserted first will be removed first.**
- Which is exactly **how queue system works in real world**. If you go to a **ticket counter to buy movie tickets,** and are first in the queue, then you will be the first one to get the tickets.

Queue

- There are two ways to implement a queue:

i. **Using array**

ii. **Using linked list**

Implement of Queue Using array:

Syntax:

```
#define Macro_Name  Value

Datatype  Array_Name[Macro_Name];

Int front=-1,rear=-1;
```

Ex:

```
#define Maxsize 10

int  Queue[Maxsize];

int front=-1,rear=-1;
```

Queue Using Array

- The **basic operations** of queue:

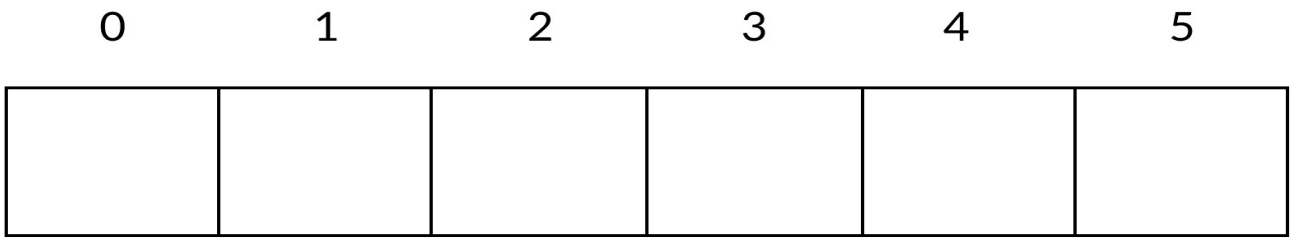
  i. ***insert:*** This operation is used ***to insert the element at the rear end*** of the queue.

  ii. ***delate:*** This operation performs the ***deletion from the front-end*** of the queue.

  iii. ***Display:*** This is the third operation that ***displays the element from front to rear.***

Queue Operations

Front = Rear = -1



Empty Queue

Insert Operation using array

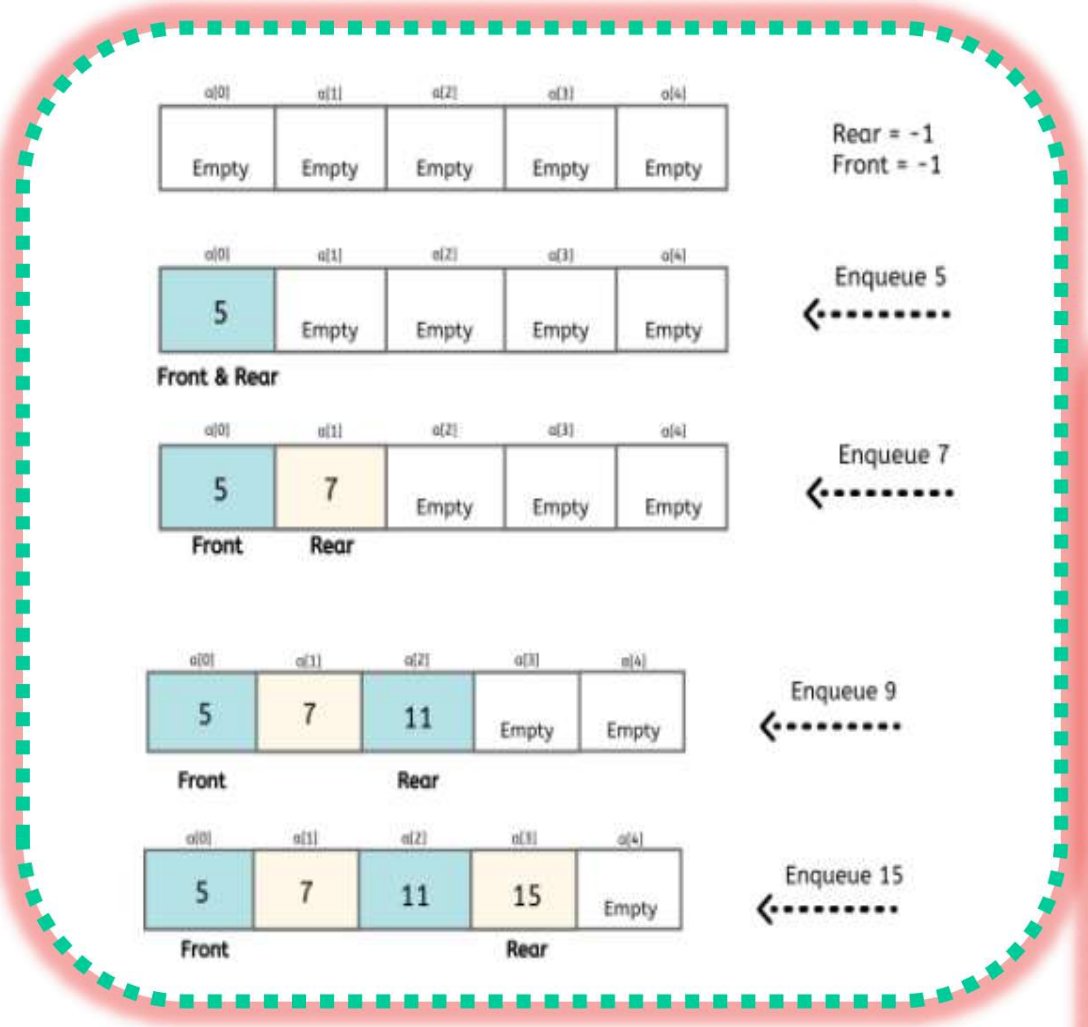
- Queues maintain **front** and **rear**.
- The following steps should be taken to insert data into a queue:

Step 1 – Check if the **queue is full.**

Step 2 – If the **queue is full**, produce **overflow error** and exit.

Step 3 – If the **queue is not full**, **increment rear** to the **next empty space.**

Step 4 – **Add data element** to the queue location, **where the rear is pointing.**




```
insert(int ele)
{
        if(rear==Maxsize-1)
        {
            printf("\n Queue is Overflow");
             return;
        }
        if(front==-1&&rear==-1)
              front=front+1;
         rear=rear+1;
         Queue[rear]=ele;
}
```

delete operation using array

- The **data where front** is **pointing** and **remove the data**

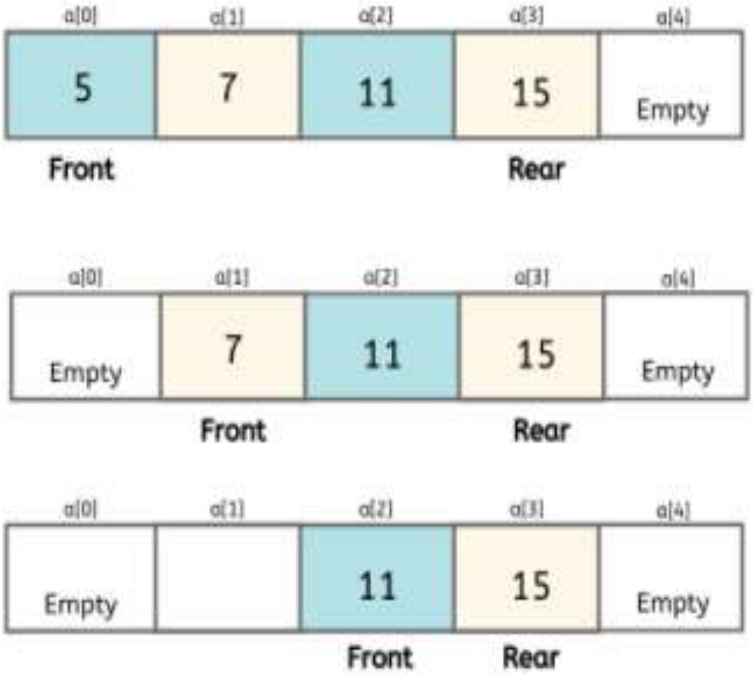
- The **following steps** are **taken** to **perform delete** operation:

  - **Step 1** – Check if the **queue is empty.**

  - **Step 2** – If the **queue is empty**, produce **underflow error** and exit.

  - **Step 3** – If the **queue is not empty**, **delete the data where front is pointing.**

  - **Step 4** – **Increment front pointer** to point to the next available data element.



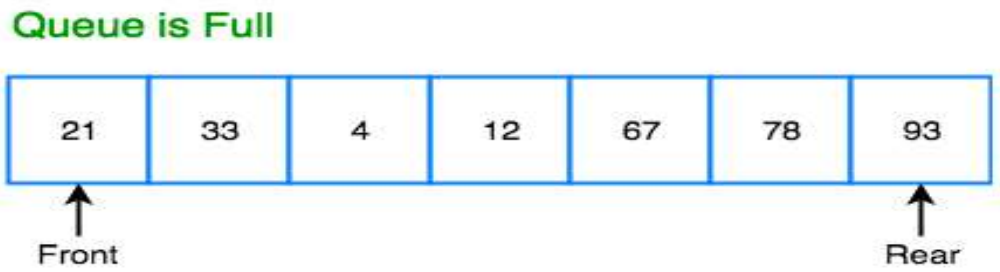

```
void delete( )
{
        if(front==-1)
        {
        printf("\Queue is underflow");
        return;
        }
        ele=Queue[front];
        if(front==rear)
             front=rear=-1;
        else
            front=front+1;
        printf(“%i is deleted”,ele);
}
```

```
void display()
{
        int i;
        if(rear==-1)
        {
                printf("\nEmpty Queue");
        }
        else
        {
                printf("\n The Queue is");
                for(i=front;i<=rear;i++)
                printf("%3i",queue[i]);
        }
}
```

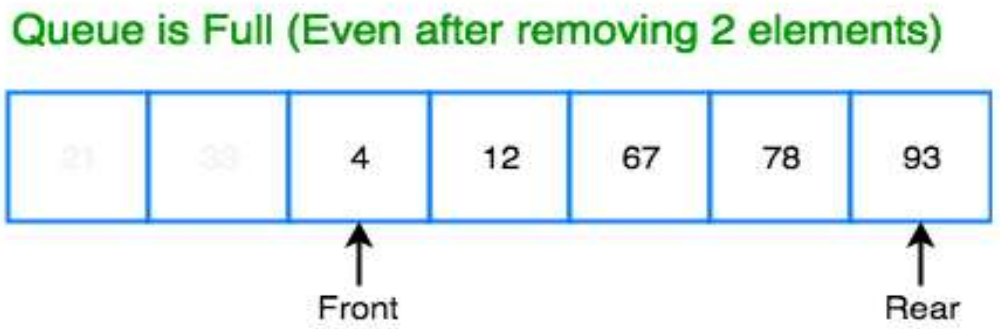
```
//program for Queue using array
#include<stdio.h>
#define maxsize 5
void insert(int);
void delete();
void display();
int queue[maxsize];
int front = -1, rear = -1,ele;
void main ()
{
   int choice;
   do
   {
      printf("\n******Main Menu******\n");
      printf("\n1.insert \n2.Delete \n3.Display");
      printf("\nEnter your choice :");
      scanf("%i",&choice);
```

```
switch(choice)
 {
    case 1:  printf("\n Enter element:");
             scanf("%i",&ele);
             insert(ele);
             break;

   case 2:    delete();
              break;

   case 3:    display();
              break;

   default: printf("\nyour choice is invalid");
      }

   } while(choice != 3) ;
}
```

Drawback of Simple Queue

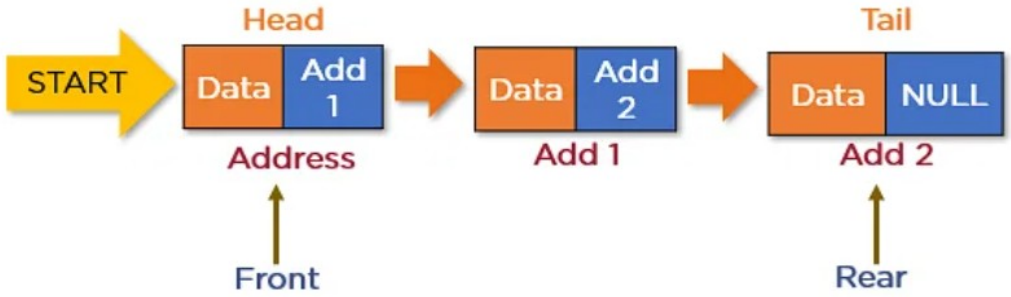


❖Even if we remove some of the elements, until the queue is reset, no new elements can be inserted.



Queue Using Linked List

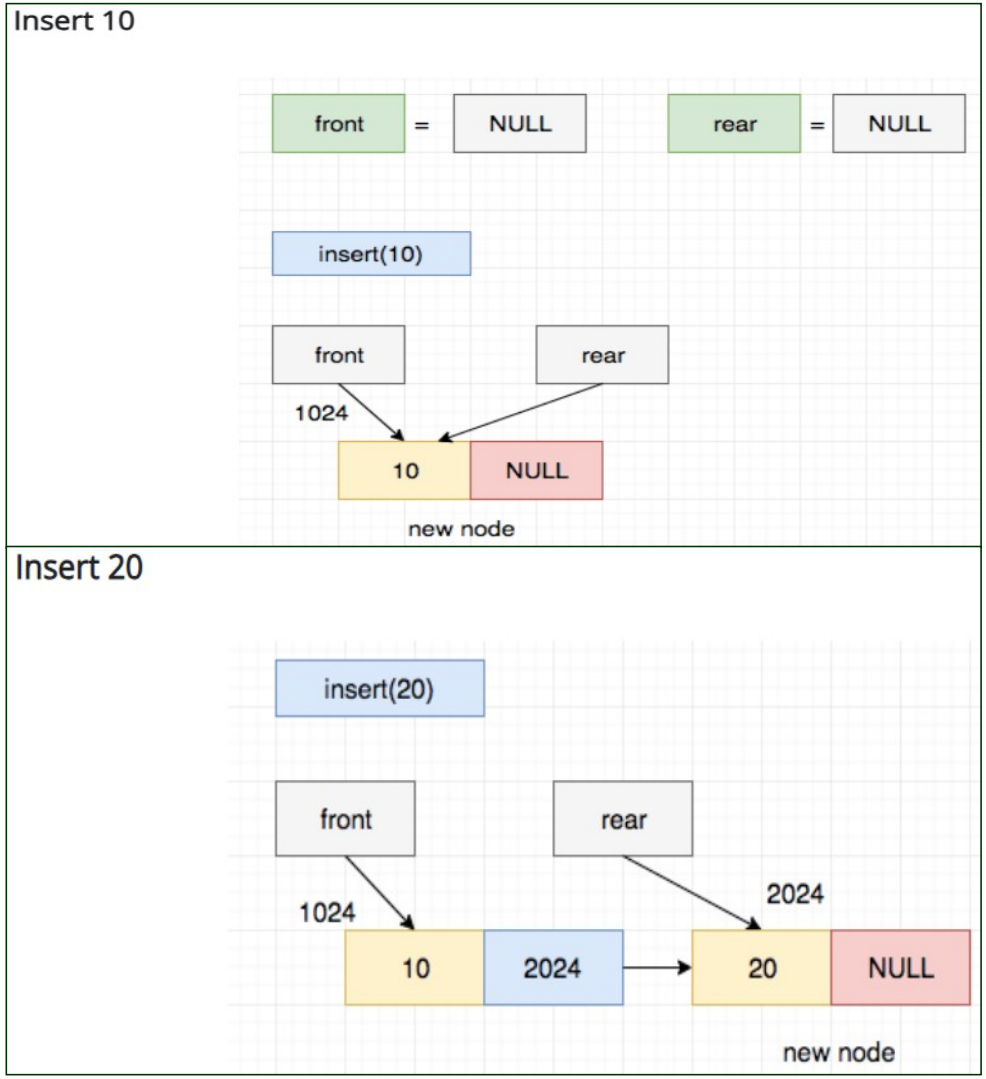
- In a **linked queue, each node of the queue** consists of **two fields**, i.e., **data** field and **address field**.
- The **front pointer stores** the location where the queue **starts**, and **rear pointer** keeps track of the **last data element** of a **queue.**

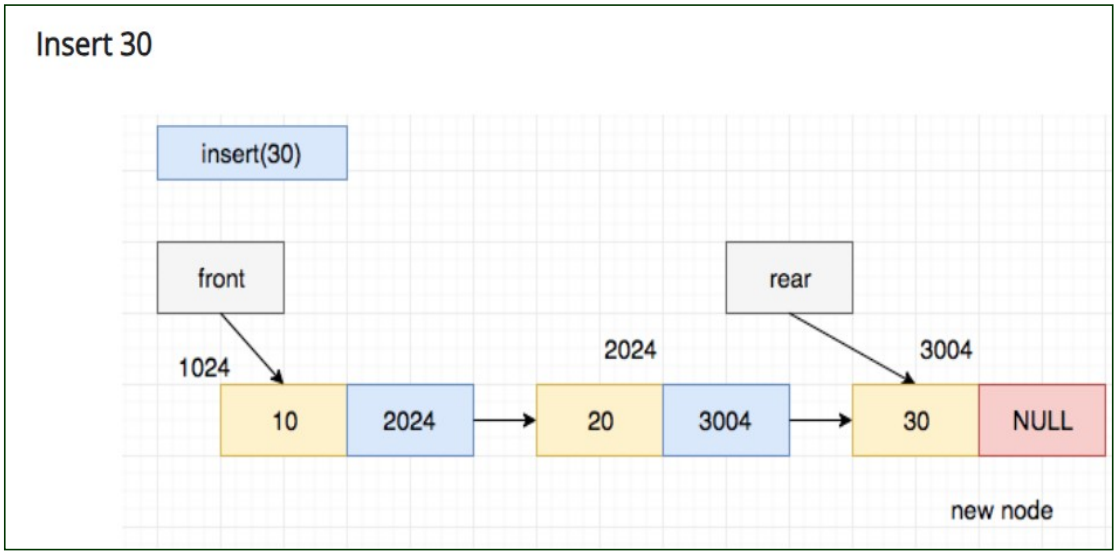



```
Struct Node
{
        int data;
        struct Node *next;
}*front=NULL,*rear=NULL.*temp=NULL;
```

- **Basic operations** of queue are:
  - i. **Insert**
  - ii. **Delete**
  - iii. **Display**

Insert Operation using linked List

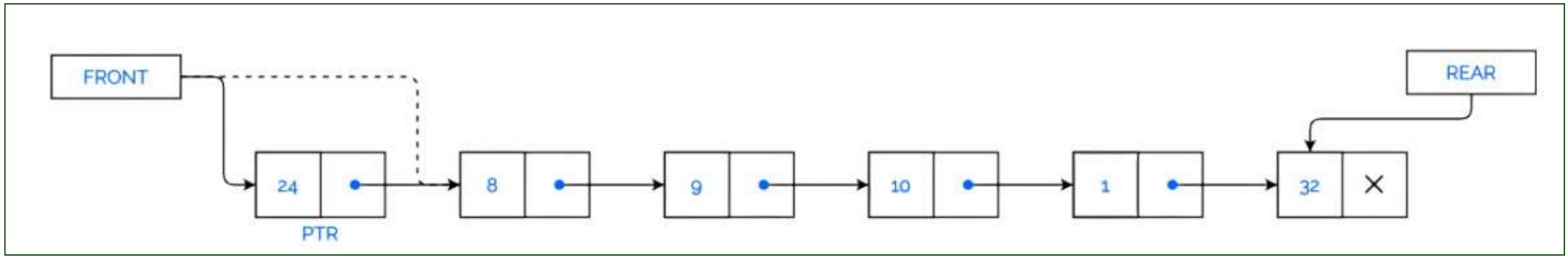


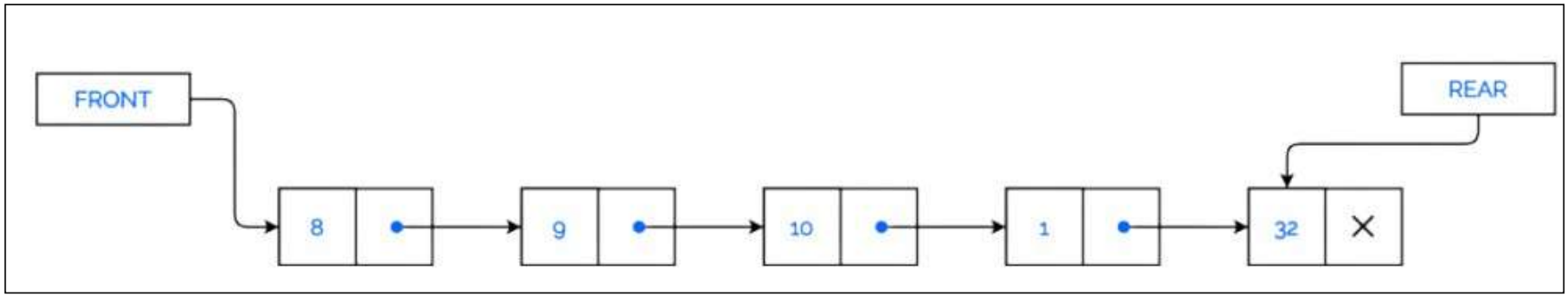


Insert Operation using linked List

```
void insert(int ele)
{
        temp=(struct Node*)malloc(sizeof(struct Node));
        temp->data=ele;
        temp->next=NULL;
        if(front==NULL)
        {
                front=rear=temp;
        }
        else
        {
                rear->next=temp;
                rear=temp;
        }
}
```

delete operation using linked list





delete operation using linked list

```
void del( )
{
        if(front==NULL)
        {
                printf("\nQueue is empty");
                return;
        }
        else
        {
                temp=front;
                front=front->next;
                ele=temp->data;
                free(temp);
                printf("\n %d is deleted",ele);
        }
}
```

Display operation using linked list

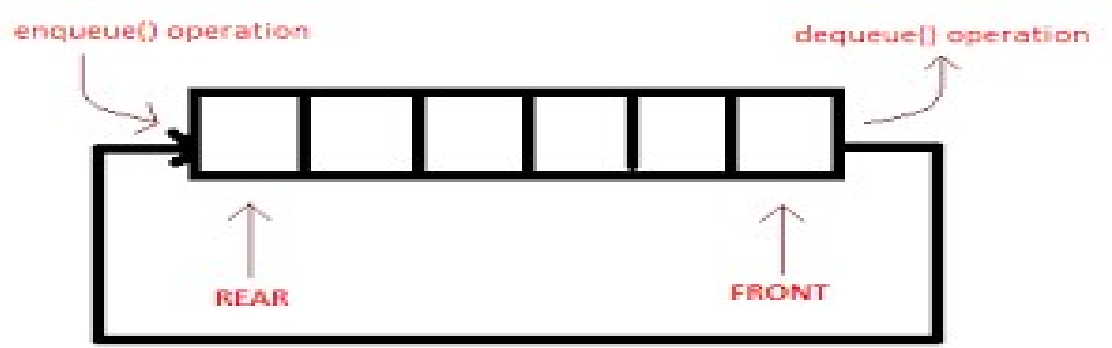
```
void display( )
{
        if(front==NULL)
                printf(“\n Queue is empty”);
        else
        {
                temp=front;
                while(temp!=NULL)
                {
                printf("%3d",temp->data);
                temp=temp->next;
                }
        }
}
```

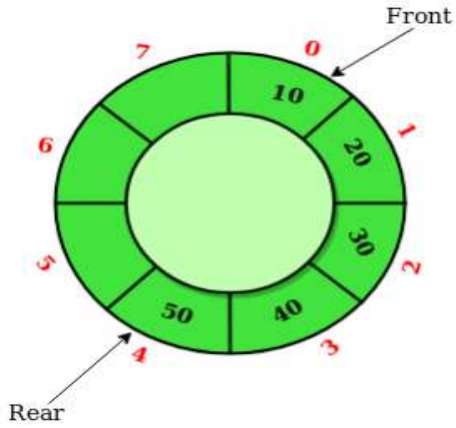
```c
//Program for Queue Using Linked List
#include<stdio.h>
Struct Node
{
        int data;
        struct Node *next;
}*front=NULL,*rear=NULL,*temp=NULL;
void insert(int);
void delete();
void display();
void main ()
{
   int choice;
   do
   {
      printf("\n******Main Menu******\n");
      printf("\n1.insert \n2.Delete \n3.Display");
      printf("\nEnter your choice :");
      scanf("%i",&choice);
```

```c
switch(choice)
 {
    case 1:  printf("\n Enter element:");
             scanf("%i",&ele);
             insert(ele);
             break;

   case 2:    delete();
              break;

   case 3:    display();
              break;

   default: printf("\nyour choice is invalid");
      }

   } while(choice != 3) ;
}
```

Circular Queue

- **Circular Queue** is also a linear data structure.
- It also follows the principle of **FIFO** rule, but **instead of ending the queue at the last position, it again starts from the first position after the last.**

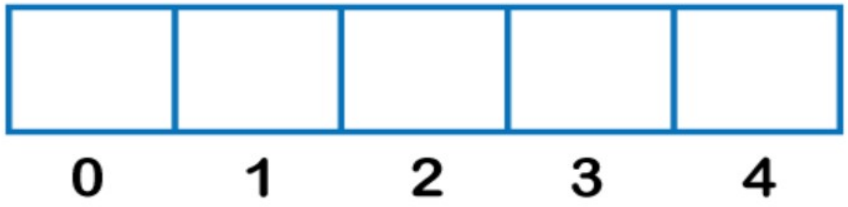




- common **real-world examples** where circular queues are used:
  - ✓Computer controlled **Traffic Signal System** uses circular queue.
  - ✓**CPU scheduling** and Memory management.

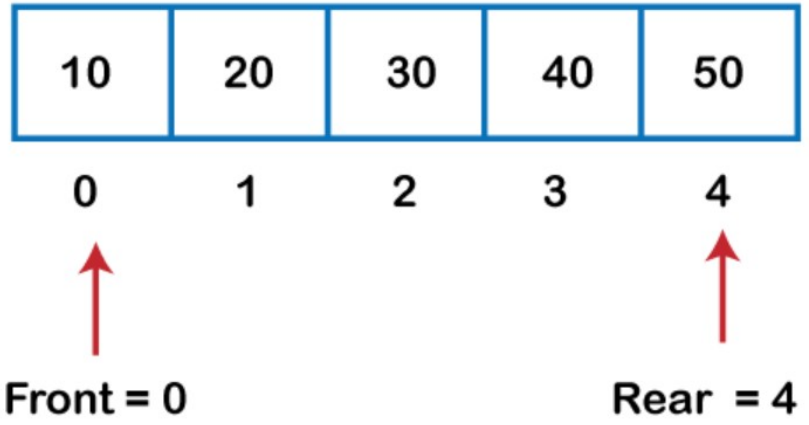
Insert Operation in Circular Queue

```
void insert(int ele)
{
   if ((front == 0 && rear == MAXSIZE-1) ||(rear==front-1))
   {
      printf("\nQueue is Full");
      return;
   }

   else if (front == -1)
   {
      front = rear = 0;
      Queue[rear] = ele;
   }
  else if (rear== MAXSIZE-1 && front != 0)
   {
      rear = 0;
      Queue[rear] = ele;
   }

   else
   {
      rear++;
      Queue[rear] = ele;
   }
}}
```



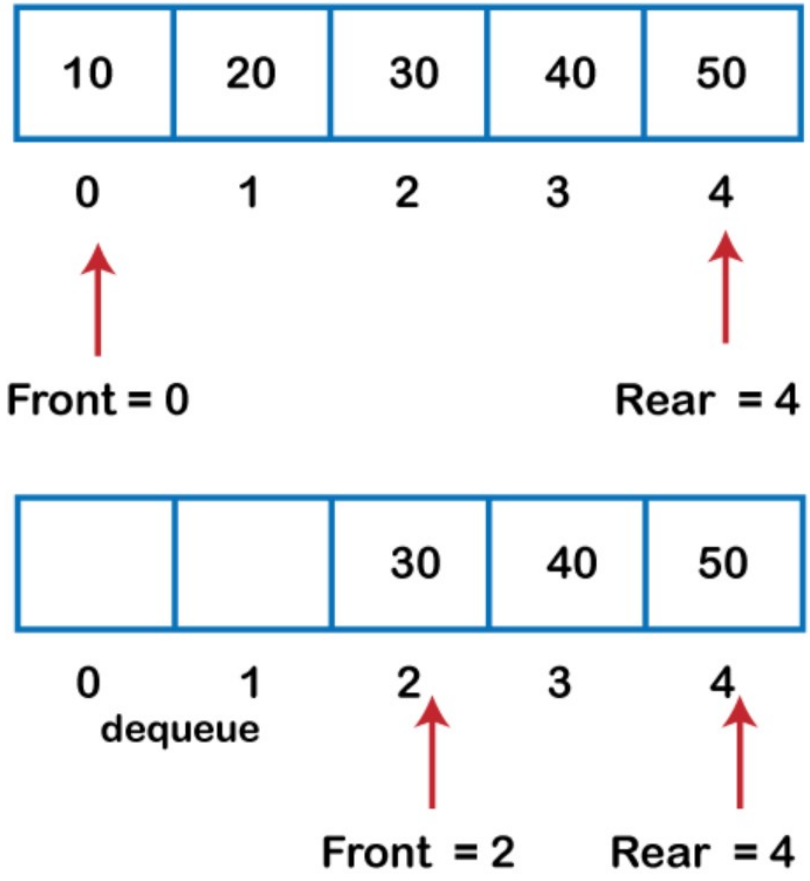
Front = -1

Rear = -1



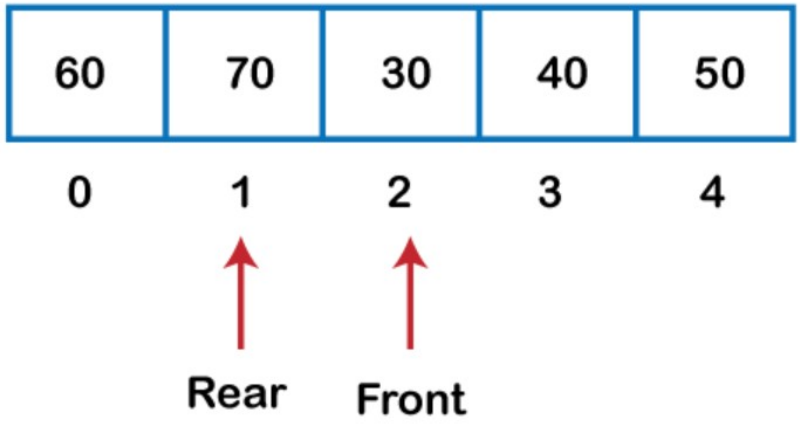
delete operation in Circular Queue

```
int del()
{
        int ele;
        if(front==–1 && rear==–1)
         {
                printf("\n UNDERFLOW");
                return 0;
        }
        ele = queue[front];
        if(front==rear)
                front=rear=–1;
        else
        {
                if(front==MAXSIZE–1)
                        front=0;
                else
                        front=front+1;
        }
        return ele;
}
```



Display operation using linked list

```
void display( )
{
        int i;
        if (front ==–1 && rear= =–1)
         printf ("\n QUEUE IS EMPTY");
        else
        {
                if(front<rear)
                 {
                        for(i=front;i<=rear;i++)
                                printf("\t %d", Queue[i]);
                }
                else
                 {
                        for(i=front;i<MAXSIZE-1;i++)
                                printf("\t %d", Queue[i]);
                        for(i=0;i<=rear;i++)
                                printf("\t %d", Queue[i]);
                }
        }
}
```

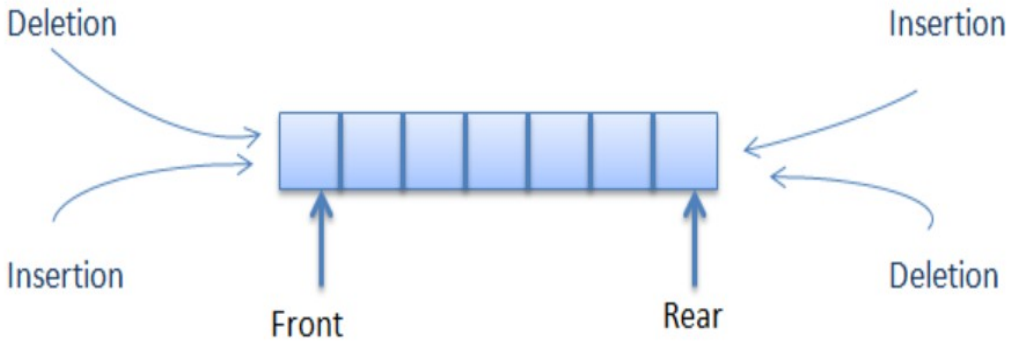


```
//Program for Circular Queue Using array
#include<stdio.h>
#define maxsize 5
void insert(int);
void delete();
void display();
int queue[maxsize];
int front = -1, rear = -1,ele;
void main ()
{
   int choice;
   do
   {
      printf("\n******Main Menu******\n");
      printf("\n1.insert \n2.Delete \n3.Display");
      printf("\nEnter your choice :");
      scanf("%i",&choice);
```

```
switch(choice)
 {
    case 1:  printf("\n Enter element:");
             scanf("%i",&ele);
             insert(ele);
             break;

   case 2:    delete();
              break;

   case 3:    display();
              break;

   default: printf("\nyour choice is invalid");
      }

   } while(choice != 3) ;
}
```

Dequeue

- The **deque** stands for **Double Ended Queue**. It is a **linear data structure** where the **insertion** and **deletion operations** are **performed** from **both ends.**
- The **representation** of a **deque** is given as follows:

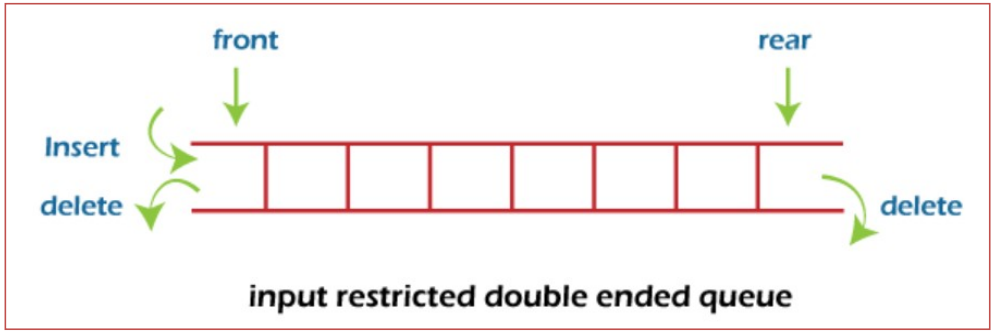


- Operations performed on deque
    i. **Insertion at front**
    ii. **Insertion at rear**
    iii. **Deletion at front**
    iv. **Deletion at rear**
- There are **two types** of **deque -**
    i. **Input restricted queue**
    ii. **Output restricted queue**

Types of Dequeue

i. Input restricted Queue:

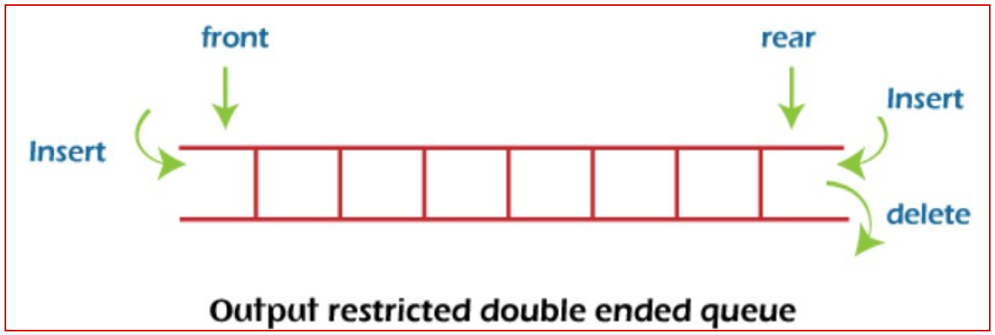
✓ In input restricted queue, **insertion operation** can be **performed at only one end**, while **deletion** can **be performed** from **both ends.**



input restricted double ended queue

ii. Output restricted Queue:

✓ In output restricted queue, **deletion operation** can be **performed** at **only one end**, while **insertion** can be performed **from both ends.**

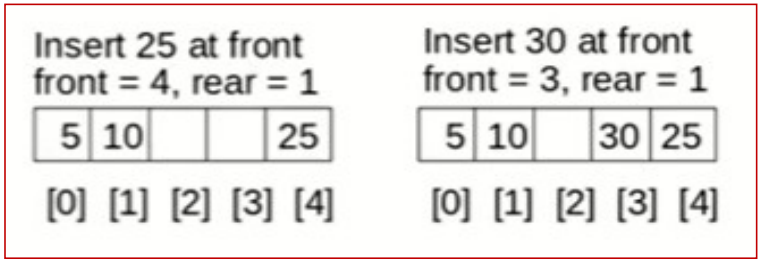


Output restricted double ended queue

Operations of Dequeue

i. Insertion at front:

- In this operation, the **element is inserted from** the **front end** of the queue.
- Before doing the operation, **we first** have to **check whether the queue is full or not.**
- If the **queue is empty**, both **rear and front** are set as 0. Now, **both** will **point** to the **first element.**
- Otherwise, check the position of the front if the **front is less than 1 (front < 1),** then reinitialize it by **front =maxsize - 1**, i.e., the **last index of the array.**

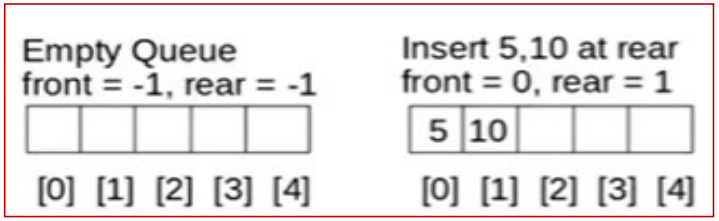



```
void insert_front(int ele)
{
        if((front==0&&rear==maxsize-1)||(front==rear+1))
          {
                printf("Overflow");
                return;
          }
          else if((front==-1) && (rear==-1))
          {
                front=rear=0;
                deque[front]=ele;
          }
          else if(front==0)
          {
                front=maxsize-1;
                deque[front]=ele;
          }
          else
          {
                front=front-1;
                deque[front]=ele;
          }
}
```

Operations of Dequeue

ii. Insertion at the rear end:

- In this operation, the **element** is **inserted from** the **rear end.**
- Before doing the operation, we **first have to check again whether** the **queue is full or not.**
- If the **queue is empty**, both **rear** and **front** are initialized **with 0**. Now, **both will point** to the **first element.**
- Otherwise, **increment the rear by 1**. If the **rear is at last index (or size - 1),** then **instead of increasing it by 1**, we have **to make it equal to 0.**




```
void insert_rear(int ele)
{
        if((front==0&&rear==maxsize-1)||(front==rear+1))
        {
                printf("Overflow");
                return;
        }
        else if((front==-1)&&(rear==-1))
        {
                rear=front=0;
                deque[rear]=ele;
        }

        else
        {
                rear=rear+1;
                deque[rear]=ele;
        }
}
```

Operations of Dequeue

iii. Deletion at the front end:

- In this operation, the **element is deleted from the front end** of the queue.
- Before doing the operation, **we first have to check whether the queue is empty or not.**
- If the **queue is empty**, we **cannot perform the deletion.**
- If the **queue is not full**, then the **element can be deleted from the front end** by **using** the **below conditions** :
- **If** the **deque has only one element**, set **rear = -1 and front = -1.**
- **Else if front is at last index, set front = 0.**
- **Else increment the front by 1.**

```
void delete_front( )
{
        if((front==-1)&&(rear==-1))
        {
                printf("Deque is empty");
                return;
        }
        else if(front==rear)
        {
           printf("\n %d is deleted from front", deque[front]);
                front=rear=-1;
        }
        else if(front==(maxsize-1))
        {
        printf("\n%d is deleted from front", deque[front]);
                front=0;
        }
        else
        {
        printf("\n %d is deleted from front", deque[front]);
                front=front+1;
        }
}
```

Operations of Dequeue

iv. Deletion at the rear end:

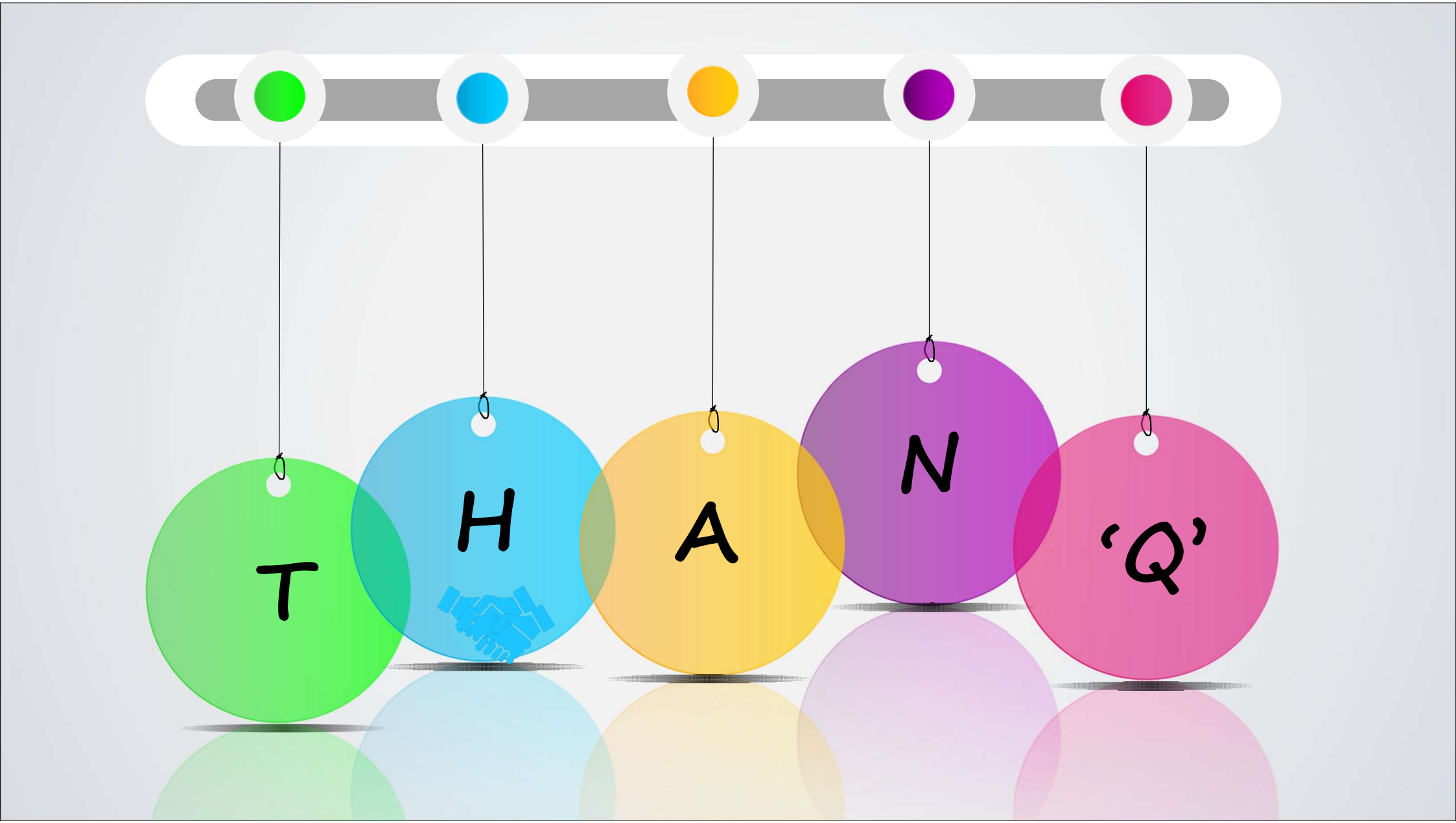
- In this operation, the **element is deleted** from the **rear end of the queue.**
- Before doing the operation, we **first have to check** whether the **queue is empty or not.**
- If the **queue is empty** ,we **cannot perform the deletion**.
- **If** the **deque has only one element**, **set rear = -1** and **front = -1.**
- **Else If** **rear = 0 , then set rear = n - 1.**
- **Else**, **decrement the rear by 1.**

```
void delete_rear()
{
        if((front==-1)&&(rear==-1))
        {
        printf("Deque is empty");
        return;
        }
        else if(front==rear)
        {
        printf("\n%d is deleted from rear",deque[rear]);
                front=rear=-1;
        }
        else if(rear==0)
        {
        printf("\n%d is deleted from rear",deque[rear]);
                rear=maxsize-1;
        }
        else
        {
        printf("\n%d is deleted from rear",deque[rear]);
                rear=rear-1;
        }
}
```

```
//Program for Dequeue Using array
#include <stdio.h>
#define maxsize 8
int deque[maxsize];
int front=-1,rear=-1,ele;
void main()
{
        int choice;
        do
        {       printf("\n******Main Menu******");
                printf("\n 1.Insert-front\t 2.Insert-rear\t 3.Delete-Front\t 4.Delete-rear\t 5.Display");
                printf("\nEnter your choice:");
                scanf("%i",&choice);
                switch(choice)
                {
                        case 1:printf("\n Enter element:");scanf("%i",&ele);insert_front(ele);break;
                        case 2:printf("\n Enter element:");scanf("%i",&ele);insert_rear(ele);break;
                        case 3:delete_front();break;
                        case 4:delete_rear();break;
                        case 5:display();break;
                        default:printf("\nyour choice is invalid");
                }
        }while(choice<6);
}
```

Operations of Dequeue

```
void display()
{
        int i=front;
        printf("\nElements in a deque are: ");
        while(i!=rear)
        {
                printf("%d ",deque[i]);
                i=(i+1)%maxsize;
        }
                printf("%d",deque[rear]);
}
```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