SLIIT
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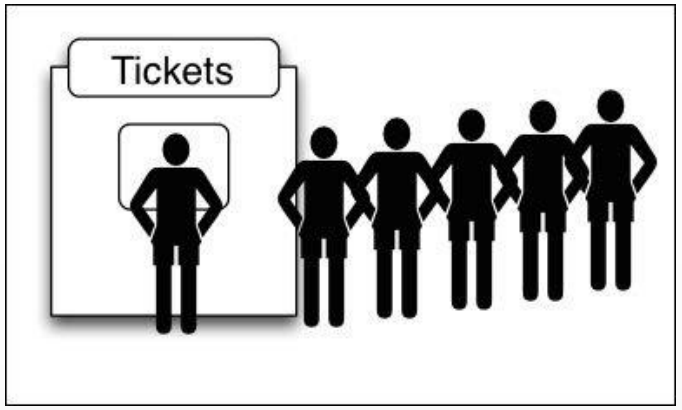
# IT2070 – Data Structures and Algorithms

## Lecture 02

## Introduction to Queue

# Queues





- Imagine a queue in real life
- The first item inserted is the first item to be removed

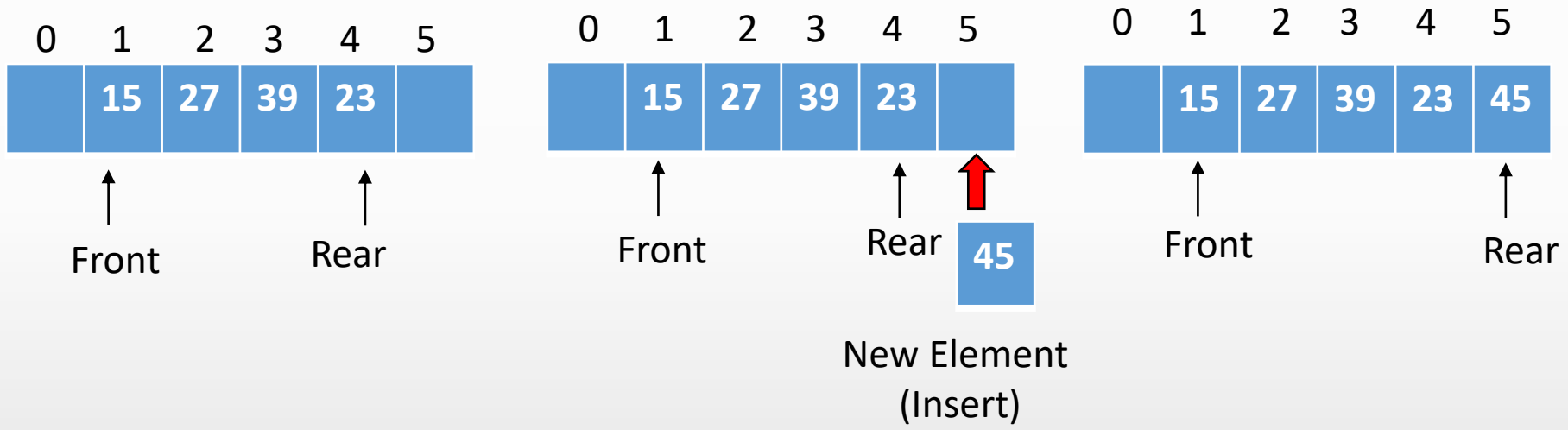
# Queues


- In a queue all insertions are made at the Rear end and deletions are made at the Front end.
- Insertions and deletions are restricted from the Middle of the Queue.

- Adding an item is called insert
- Removing an item is called remove

- The elements are inserted and removed according to the First-In-First-Out (FIFO) principle.

# Queue - Insert

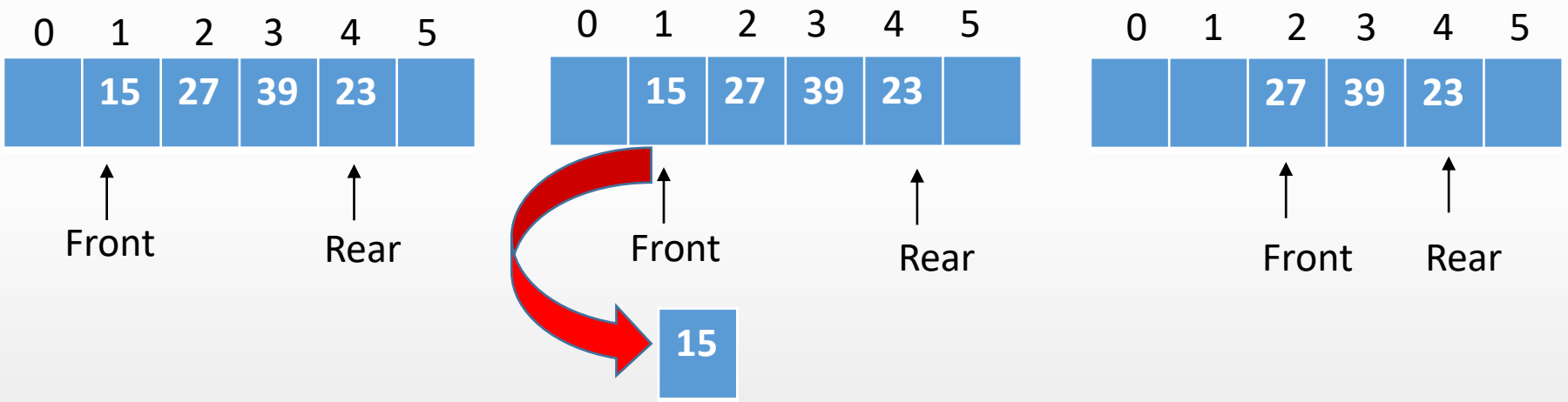



Before inserting

Item 45 is inserted to the rear

After inserting

# Queue - Remove

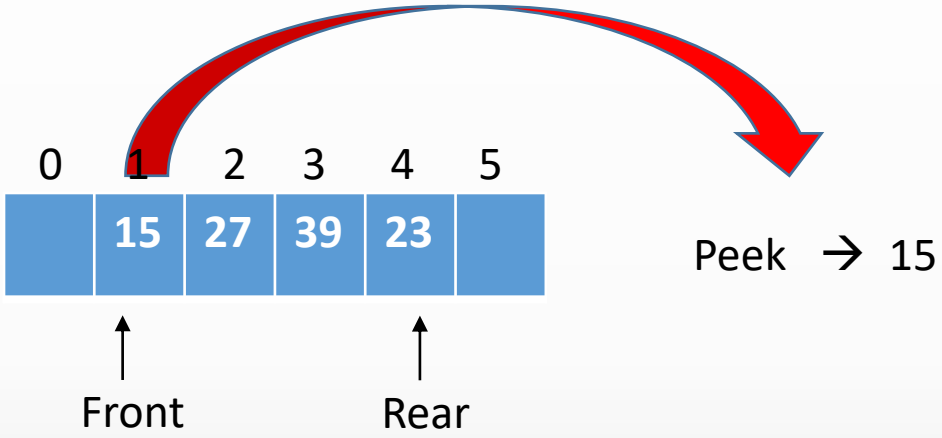


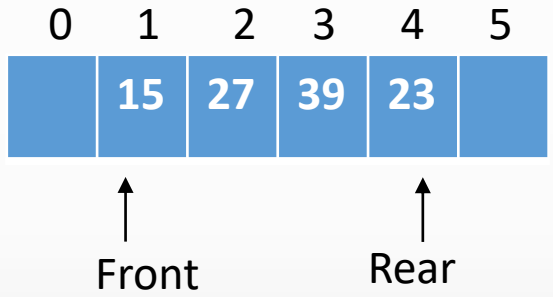

Before removing

Front item is removed

After removing

# Queue - PeekFront



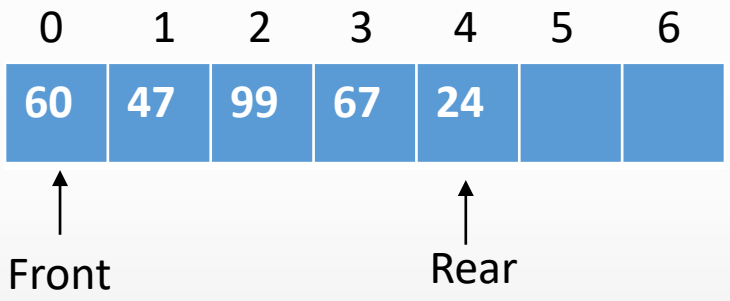



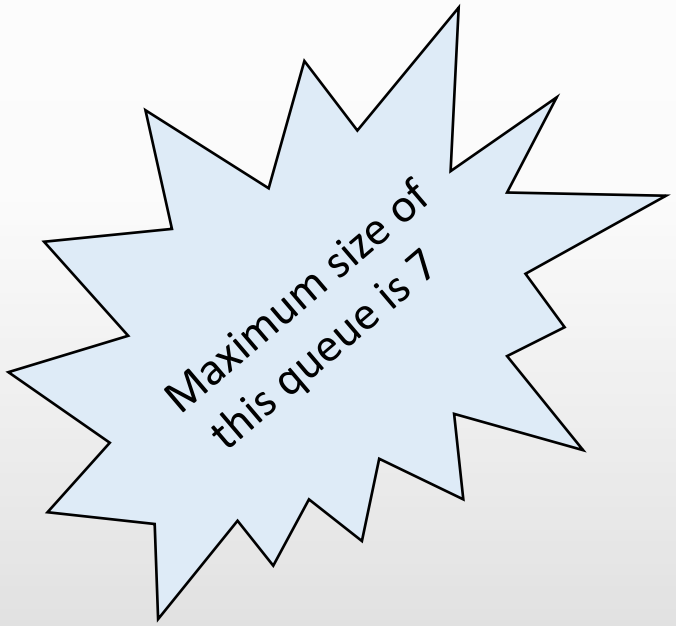

**Queue remains the same**

Peek is used to read the value from the Front of the queue without removing it. You can peek only the Front item, all the other items are invisible to the queue user.

# Question 01

Draw the Queue frame after performing the below operations to the queue given below.




i) Insert item 33
ii) Insert item 53
iii) peekFront
iv) remove
v) remove
vi) remove
vii) remove
viii) remove

# Uses of Queue

- There are various queues quietly doing their job in a computer's operating system.
  - printer queue
  - stores keystroke data as you type at the keyboard
  - pipeline

# Queue - Implementation

Queue implementation using an **array** with restricted access

- Constructor creates a new Queue of a size specified in its argument.
- Variable ***front***, which stores the index of the item on the front of the queue.
- Variable ***rear***, which stores the index of the item on the end of the queue.
- Variable *nItems*, which stores the total number of the items in the queue.

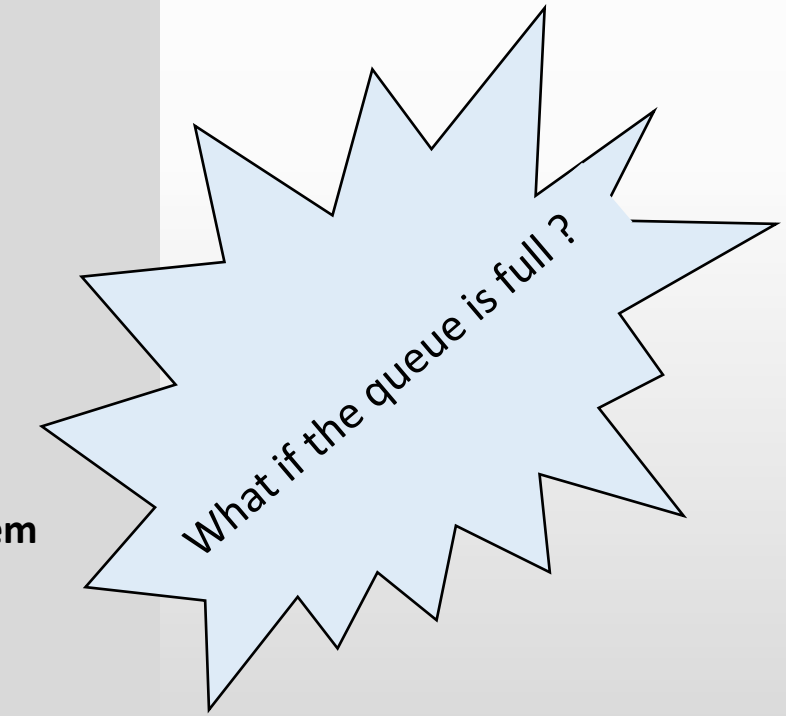
```
class QueueX {
    private int maxSize;    // size of queue array
    private int [] queArray;
    private int front;          //front of the queue
    private int rear;          //rear of the queue
    private int nItems;  //no of items of the queue

    publc QueueX (int s) {// constructor

                maxSize = s;      // set array size
                queArray = new int [maxSize];
                front = 0;
                rear = -1;
                nItems = 0;           // no items
    }
    ……….
    ……….
}
```

# Queue – Implementation - insert

```
class QueueX {
      private int maxSize;    // size of queue array
      private int [] queArray;
      private int front;          //front of the queue
      private int rear;          //rear of the queue
      private int nItems;  //no of items of the queue

      publc QueueX(int s)  {  // constructor

                  maxSize = s;       // set array size
                  queArray = new int [maxSize];
                  front = 0;
                  rear = -1;
                  nItems = 0;           // no items
      }
     public void insert(int j)  {
                  // increment rear
                  // insert an item
     }
}
```

# Queue – Implementation - insert

```
class QueueX {
        private int maxSize;    // size of queue array
        private int [] queArray;
        private int front;          //front of the queue
        private int rear;          //rear of the queue
        private int nItems;  //no of items of the queue

        publc QueueX(int s) { // constructor

                    maxSize = s;      // set array size
                    queArray = new int [maxSize];
                    front = 0;
                    rear = -1;
                    nItems = 0;           // no items
        }
      public void insert(int j) {
                  // increment rear and insert an item
                   queArray[++rear] = j;
                   nItems++;
      }
}
```



# Queue – Implementation - insert

```
class QueueX {
        private int maxSize;    // size of queue array
        private int [] queArray;
        private int front;          //front of the queue
        private int rear;           //rear of the queue
        private int nItems;  //no of items of the queue

        publc QueueX(int s) {// constructor

                        maxSize = s;       // set array size
                        queArray = new int [maxSize];
                        front = 0;
                        rear = -1;
                        nItems = 0;            // no items
        }
```

```
public void insert(int j) {
                // check whether queue is full
                 if (rear == maxSize – 1)
                        System.out.println(“Queue is full”);
                else {
                        queArray[++rear] = j;
                        nItems++;

                }
        }
}
```

# Queue – Implementation – remove/peekFront

```
class QueueX {
      private int maxSize;    // size of queue array
      private int [] queArray;
      private int front;          //front of the queue
      private int rear;          //rear of the queue
      private int nItems;  //no of items of the queue

      publc QueueX(int s) { // constructor

                  maxSize = s;      // set array size
                  queArray = new int [maxSize];
                  front = 0;
                  rear = -1;
                  nItems = 0;           // no items
      }
    public void insert(int j) {

                 // check whether queue is full
                  if (rear == maxSize – 1)
                      System.out.println(“Queue is full”);
                 else {

                                  queArray[++rear] = j;
                                  nItems++;

                 }
    }
}
```

```
public int remove()  {
            // check whether queue is empty
            // if not
           // access item and increment front
 }

public int peekFront()  {
            // check whether queue is empty
            // if not
             // access item
 }
```

# Queue – Implementation – remove

```
class QueueX{
        private int maxSize;    // size of queue array
        private int [] queArray;
        private int front;          //front of the queue
        private int rear;          //rear of the queue
        private int nItems;  //no of items of the queue

        publc QueueX(int s) {// constructor

                        maxSize = s;       // set array size
                        queArray = new int [maxSize];
                        front = 0;
                        rear = -1;
                        nItems = 0;            // no items
       }
     public void insert(int j) {

                       // check whether queue is full
                        if (rear == maxSize – 1)
                             System.out.println(“Queue is full”);
                       else {

                                          queArray[++rear] = j;
                                          nItems++;

                       }
     }
}
```

```
public int remove() {
        if (nItems == 0)  {
            System.out.println(“Queue is empty”);
            return -99;
        }
        else   {
            nItems--;
            return queArray[front++];
        }
}
```

# Queue – Implementation – peekFront

```
class QueueX{
        private int maxSize;    // size of queue array
        private int [] queArray;
        private int front;          //front of the queue
        private int rear;          //rear of the queue
        private int nItems;  //no of items of the queue

        publc QueueX(int s) {// constructor

                        maxSize = s;       // set array size
                        queArray = new int [maxSize];
                        front = 0;
                        rear = -1;
                        nItems = 0;            // no items
        }
    public void insert(int j) {

                    // check whether queue is full
                     if (rear == maxSize – 1)
                          System.out.println(“Queue is full”);
                    else {

                                        queArray[++rear] = j;
                                        nItems++;

                    }
    }
}
```

```
public int peekFront() {
     if (nItems == 0)  {
          System.out.println(“Queue is empty”);
          return -99;
      }
     else {
          return queArray[front];
     }
}
```

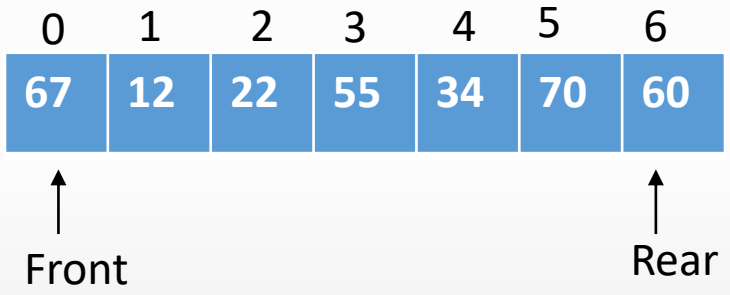
# Question 02

isEmpty() method of the Queue class returns true if the Queue is empty and isFull() method returns true if the Queue is full.

Implement isEmpty() and isFull() methods of the Queue class.

# Question 03

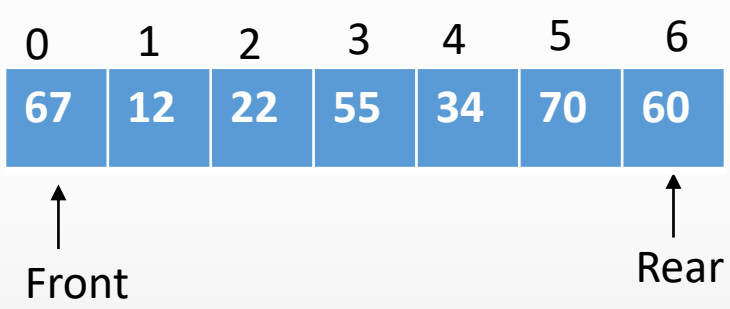
Draw the Queue frame after performing the below operations to the queue given below.

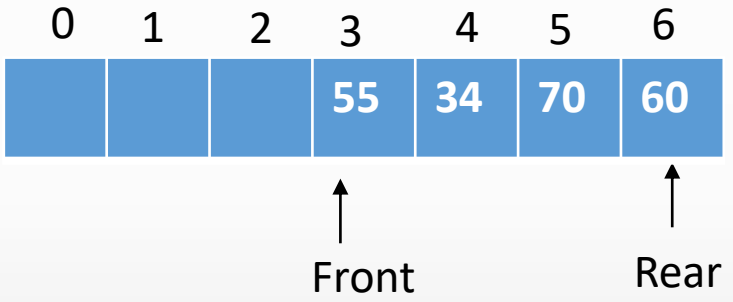



i) remove
ii) remove
iii) remove
iv) Insert item 88

# Question 03 Contd..

Draw the Queue frame after performing the below operations to the queue given below.



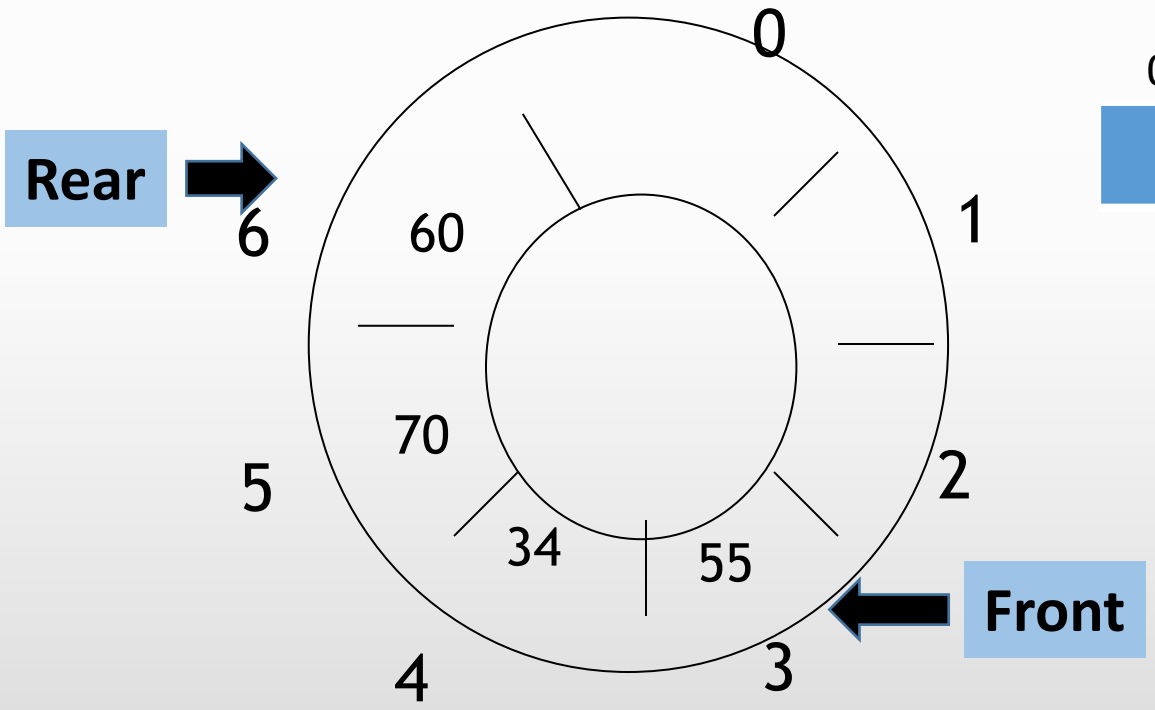

i) remove
ii) remove
iii) remove
iv) Insert item 88

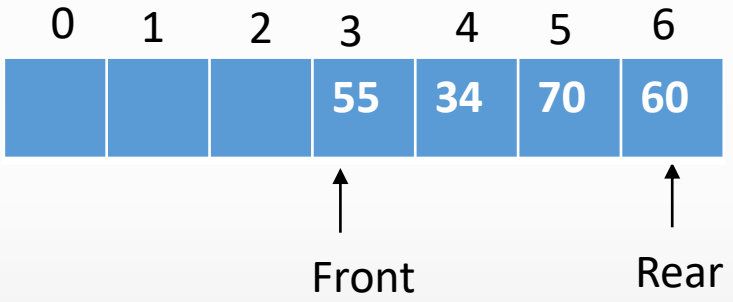
**Although the queue is not full we cannot insert more elements.**

**Any Suggestions?**

# How to overcome this situation??

We can use a Circular Queue



# Circular Queue

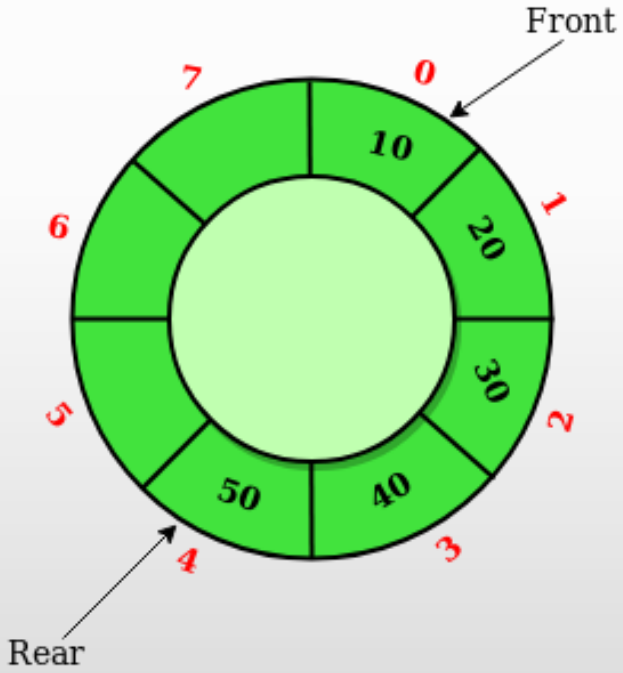
- Circular queues are queues that wrap around themselves.
- These are also called ring buffers.
- The problem in using the linear queue can be overcome by using circular queue.
- When we want to insert a new element we can insert it at the beginning of the queue.

  i.e. if the queue is not full we can make the rear start from the beginning by wrapping around

  **If rear was 3 then the next element should be stored in index 4**
  **If rear was 7 then the next element should be stored in index 0**

# Question 04

Draw the Queue frame after performing the below operations to the circular queue given below.




i) insert(14);
ii) insert(29);
iii) insert(33);
iv) insert(88);
v) peekFront();
vi) remove();
vii) remove();
viii) insert(90);
ix) insert(100);
x) peekFront();

## Inserting an element to Linear Queue

```
public void insert(int j)  {
      // check whether queue is full
      if ( rear == maxSize - 1)
          System.out.println("Queue is full");
      else  {
          queArray[++rear] = j;
          nItems++;

      }
}
```

## Inserting an element to Circular Queue

```
public void insert(int j)  {
      // check whether queue is full
      if (nItems == maxSize)
          System.out.println("Queue is full");
      else {
          if(rear == maxSize - 1)
              rear = -1;

          queArray[++rear] = j;

          nItems++;
      }
}
```

## Removing an element from Linear Queue

```
public int remove()  {
      // check whether queue is empty
      if ( nItems == 0)
          System.out.println("Queue is empty");
      else {
          nItems--;
          return queArray[front++];

      }
}
```

## Removing an element from Circular Queue

```
public int remove() {
      // check whether queue is empty
      if ( nItems == 0)
          System.out.println("Queue is empty");
      else  {
          int temp = queArray[front++];
          if (front == maxSize)
              front  = 0;

          nItems--;

          return temp;

      }
}
```

# Question 05

Implement isFull(), isEmpty() and peekFront() methods of the Circular Queue class.

# Question 06
# Creating a Queue

Using the implemented QueueX class, Write a program to create a queue with maximum size 10 and insert the following items to the queue.

10 25 55 65 85

Delete all the items from the queue and display the deleted items.

# Creating a Queue

```
class QueueApp {
        public static void main(String[] args) {
                QueueX  theQueue = new QueueX(10);  // create a queue with max size 10

                 theQueue. insert(10);  // insert given items
                 theQueue. insert(25);
                 theQueue. insert(55);
                 theQueue. insert(65);
                 theQueue. insert(85);

                while( !theQueue.isEmpty() ) {    // until it is empty, delete item from queue

                        int val = theQueue.remove();
                        System.out.print(val);
                        System.out.print(" ");
                }
        }
} // end of class
```

# References

1. Mitchell Waite,Robert Lafore, Data Structures and Algorithms in Java,2nd Edition, Waite Group Press,1998.