

# Queue

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# Queue

- Ordered collection of homogeneous elements.
- Non-primitive linear data structure.
- A new element is added at one end called **rear end** and the existing elements are deleted from the other end called **front end**.
- This mechanism is called **First-In-First-Out (FIFO)**
- Total no. of elements in queue =  $\text{rear} - \text{front} + 1$

Queue:

-It defines linear structure, with ordered collection of homogeneous elements.

-It is non-primitive data structure

- rEFERENCES: Rear , Front

-Insertion : addition of new element: Rear

-DEletion : deletion of an element : Front

-FIFO: First In First Out

-Insertion: enqueue()

-Deletion : dequeue

ways to define queue:

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1. Using Array

5

2. Using Linkedlist



Insertion : Rear : 1,2,3,4,5

Delete : Front: 1 ,2

# Queue Operations

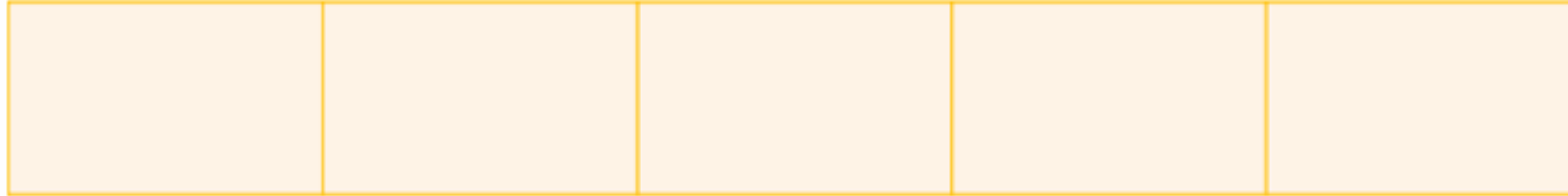
0

1

2

3

4



66

Rear

Front

Insert: 1,2,3,4,5

Deletion: 1,2, 3, 4,5

## simple queue



Front

Rear

- Insertion: Rear
- Deletion: Front

Types of queue:

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### 1. Simple Queue

- Follow FIFO strictly.
- Insertion :rear and deletion :front
- Insertion: enqueue()
- Deletion: dequeue()

### 2. Circular Queue:

### 3. Double-Ended Queue (Deque)

### 4. Priority Queue

```
void enqueue(int x)
```

```
{
```

```
    if(isFull())
```

```
    {
```

```
        System.out.println("Queue is full !");
```

```
    }
```

```
    else
```

```
    {
```

```
        if(front == -1)
```

```
        {
```

```
            front = 0; // set front to 0 if queue is empty
```

```
        }
```

```
        rear++;
```

```
        Q[rear] = x;
```

```
        System.out.println(x + "Inserted");
```

```
    }
```

```
}
```

simple queue

5

7

Front

Rear

# Queues

-----

- Unlike arrays, where insertion and deletion can happen at any end.
- In Queues, insertion (Enqueue) and deletion (Dequeue) can happen at only one end each.
- Insertion happens at the rear end and deletion happens at the front
- Queues follow FIFO First in First out structure, i.e. the element added first (Enqueued) will go out of the queue first (Dequeued)
- Unlike stack, which follows, LIFO, last in first out, and stack where both insertion and deletion happens at one end.

## Queue Operations

- Enqueue: Adding a new item to the Queue Data Structure, in other words, enqueueing new item to Stack DS.

If the Queue is full, then it is said to be in an overflow condition

- Dequeue: Removing an item from the Queue, i.e. dequeuing an item out.

If a Queue is empty then it is said to be in an underflow condition

- IsEmpty: This returns True If the Queue is empty else returns False



## Representation of Queue

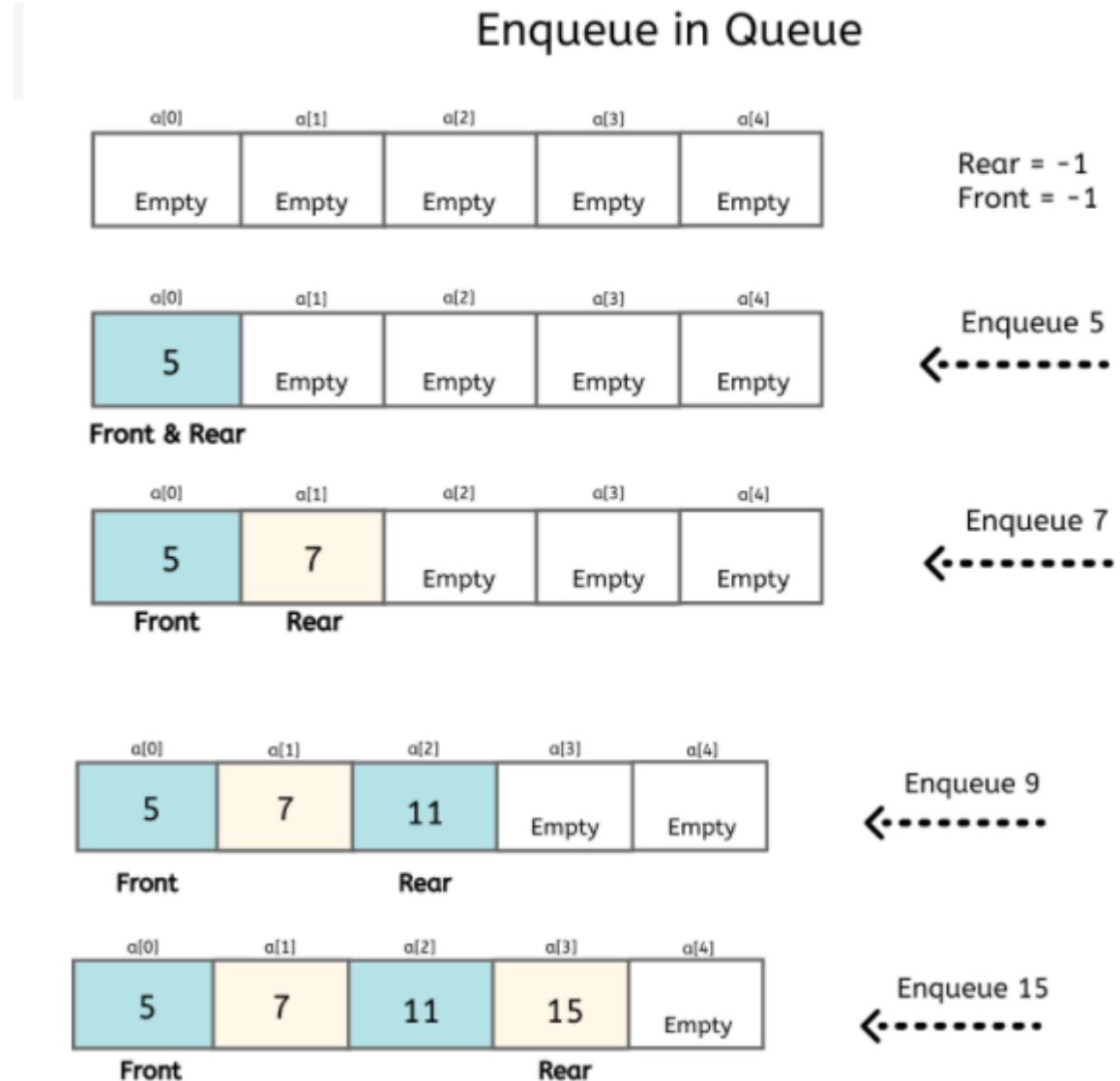
Queue as a data structure can be represented in two ways.

- Stack as an Array (Most popular)
- Stack as a struct (Popular)
- Stack as a Linked List.

# 1. Enqueue()

When we require to add an element to the Queue we perform Enqueue() operation.

Push() operation is synonymous of insertion/addition in a data structure.



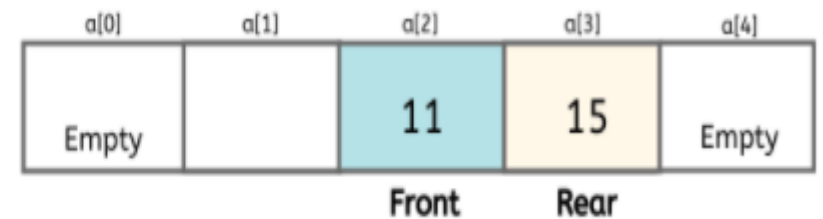
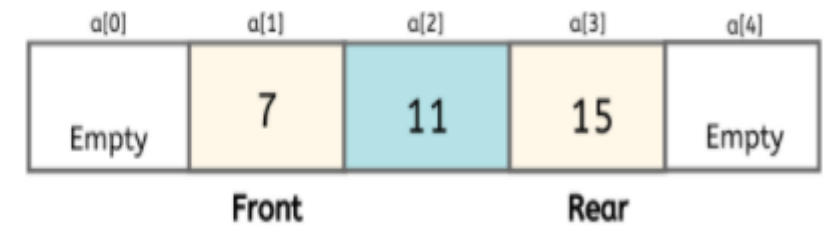
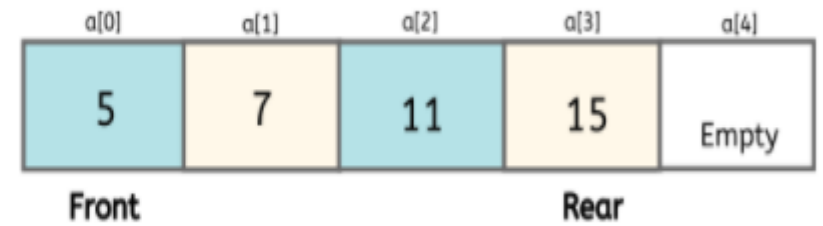
## 2. Dequeue()

**When we require to delete/remove an element to the Queue we perform Dequeue() operation.**

**Dequeue() operation is synonymous of deletion/removal in a data structure.**

Enqueue always happens at the rear

Dequeue always happens at the front



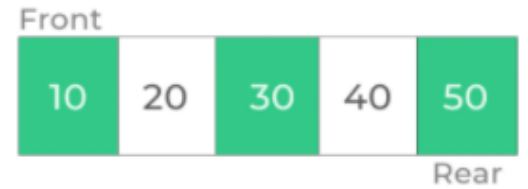
Deque  
← .....  
5, dequeued

Dequeue  
← .....  
7, dequeued

# Simple Queue

A simple queue are the general queue that we use on perform insertion and deletion on FIFO basis i.e. the new element is inserted at the rear of the queue and an element is deleted from the front of the queue.

## Simple Queue



## Applications of Simple Queue

The applications of simple queue are:-

- CPU scheduling
- Disk Scheduling
- Synchronization between two process.

## Representation of Queue

Queue as a data structure can be represented in two ways.

- Stack as an Array (Most popular)
- Stack as a Linked List.

## Applications and uses for Queues

- Heavily used in almost all applications of the operating system, to schedule processes, moving them in or out of process scheduler.
- FCFS, SJF etc
- Asynchronously i.e. when data resource may be the same but not received at the same rate.
- Anything that has to do with process and schedule, in the system or code.

## 3 states of the queue

1. Queue is empty

**FRONT=REAR**

2. Queue is full

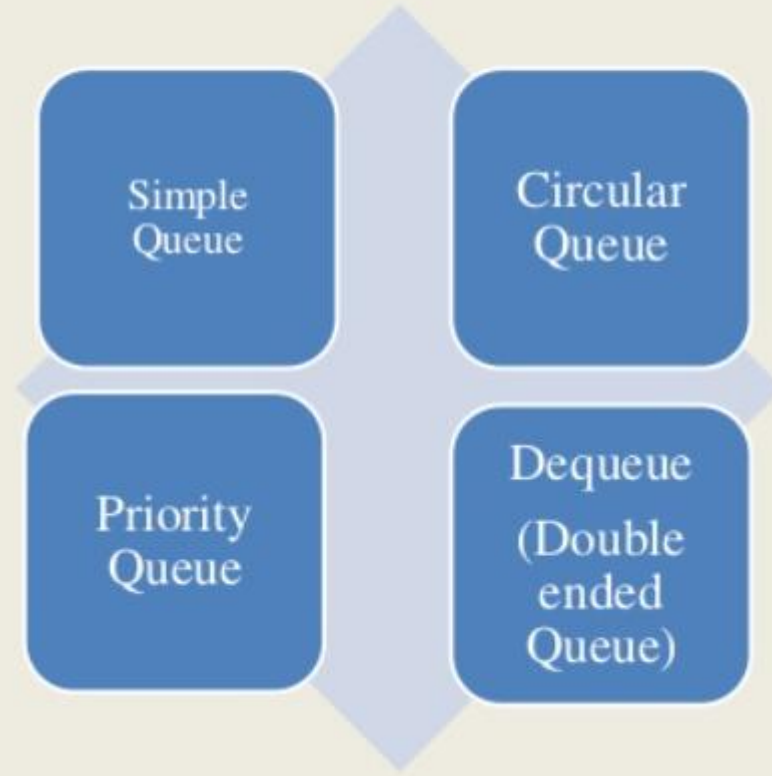
**REAR=N**

3. Queue contains element  $\geq 1$

**FRONT < REAR**

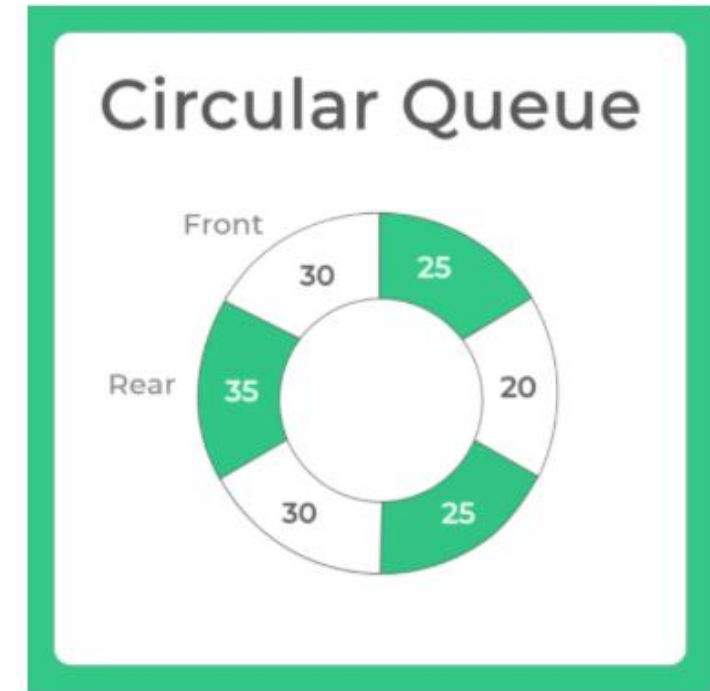
**NO. OF ELEMENT = REAR - FRONT + 1**

## Type of queue



# Circular Queue

Circular queue is a type of queue in which all nodes are treated as circular such that the first node follows the last node. It is also called ring buffer. In this type of queue operations are performed on first in first out basis i.e the element that has inserted first will be one that will be deleted first.



## Applications of Circular Queue

The applications of circular queue are:-

- CPU scheduling
- Memory management
- Traffic Management



# Circular Queue

- In a circular queue, all nodes are treated as circular. Last node is connected back to the first node.
- Circular queue is also called as **Ring Buffer**.
- It is an abstract data type.
- Circular queue contains a collection of data which allows insertion of data at the end of the queue and deletion of data at the beginning of the queue

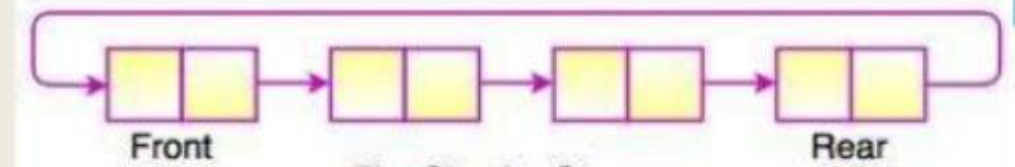


Fig. Circular Queue

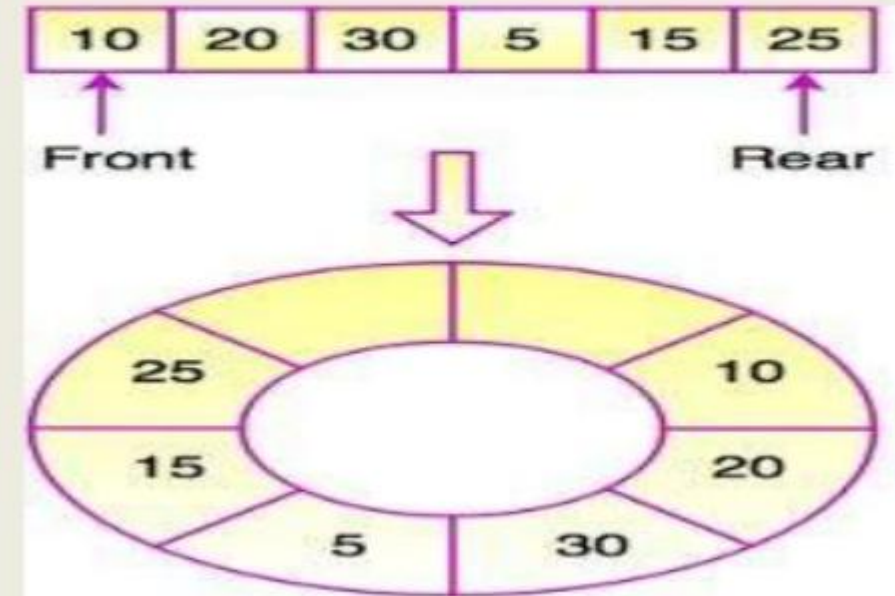
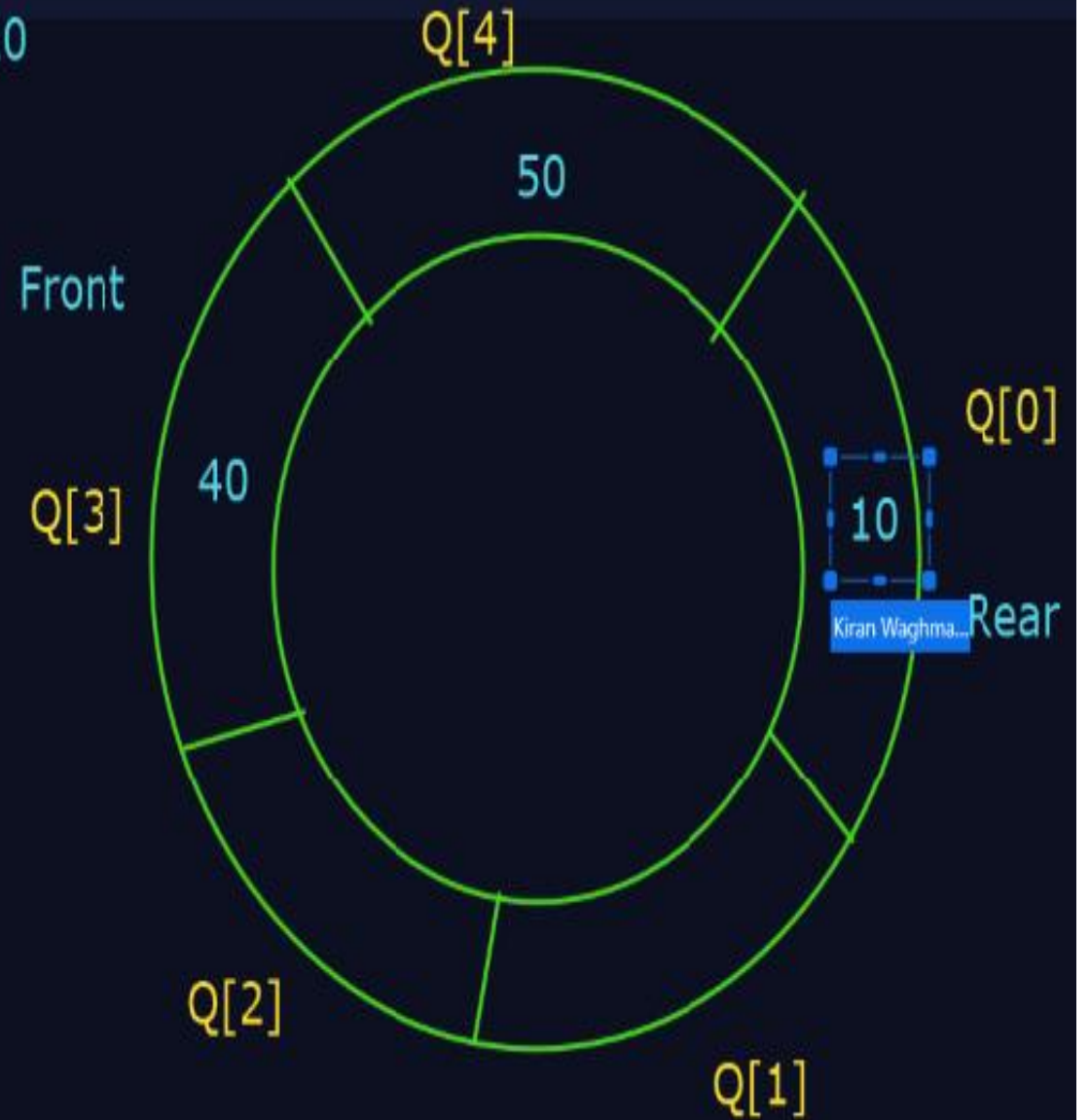


Fig. Circular Queue

## 2. Using Linkedlist

$$\begin{aligned}\text{Front} &= (\text{Front} + 1) \% \text{size} \\ &= 3 \% 5 \\ &= 3\end{aligned}$$

$$\begin{aligned}\text{Rear} &= (\text{Rear} + 1) \% \text{size} \\ &= 5 \% 5 \\ &= 0\end{aligned}$$



## 1. Simple Queue

- Follow FIFO strictly.
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- Insertion: enqueue()
- Deletion: dequeue()

## 2. Circular Queue:

## 3. Double-Ended Queue (Deque)

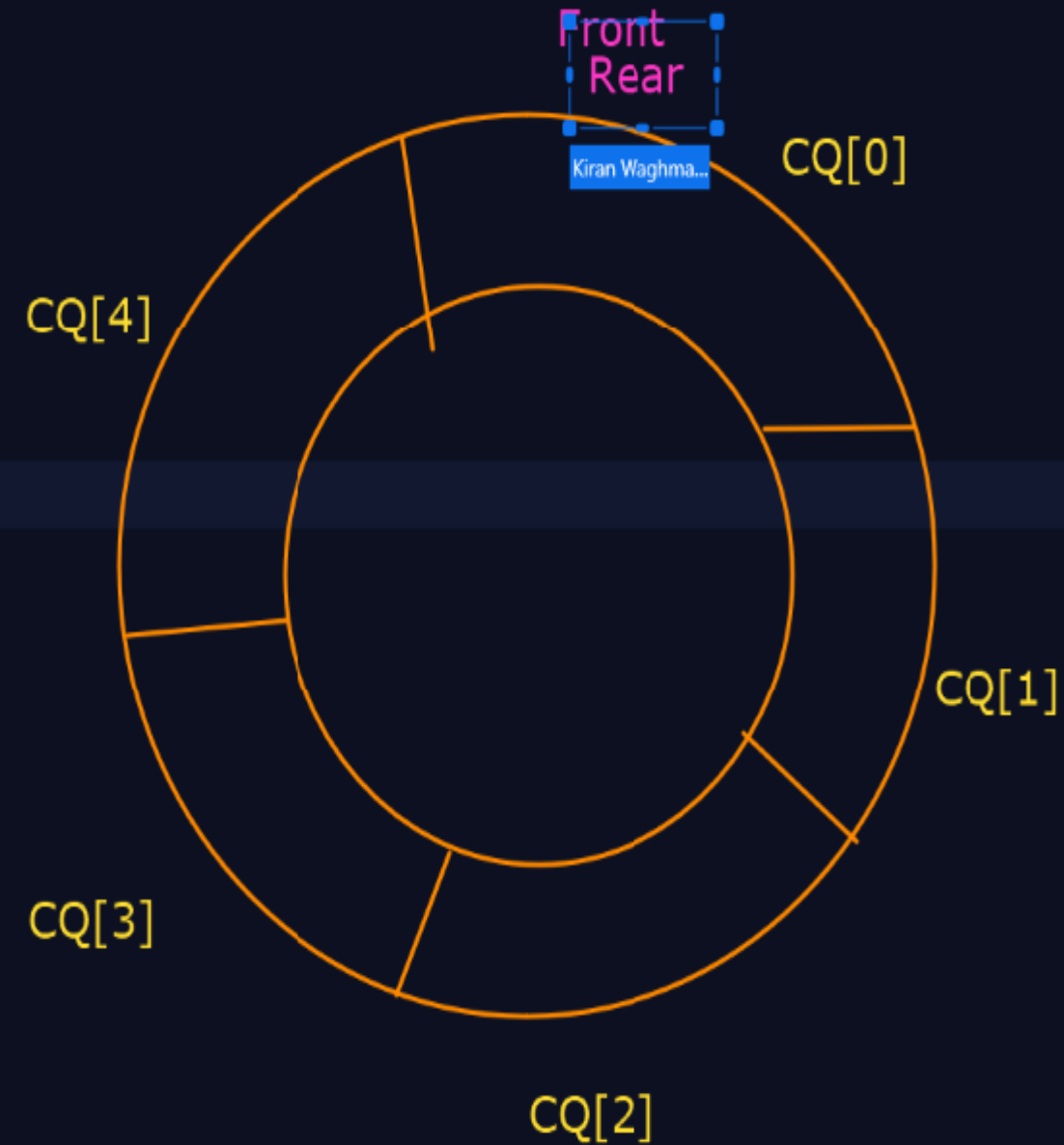
## 4. Priority Queue

$\text{Front} = (\text{Front} + 1) \% \text{size}$   
 $\text{Rear} = (\text{rear} + 1) \% \text{size}$

rear=5 new location ?

10

20



## 1. Simple Queue

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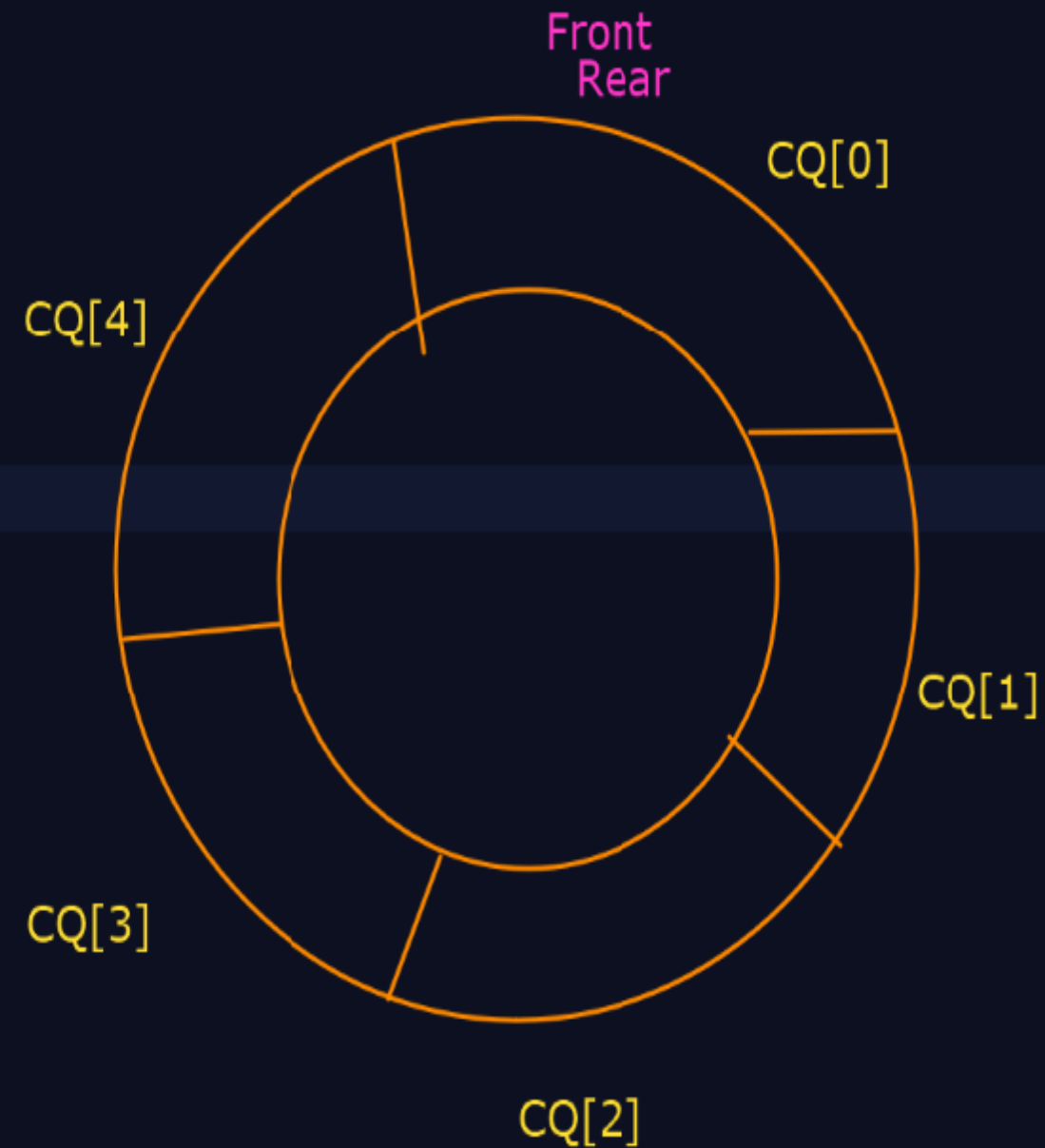
$$\begin{aligned}\text{front} &= (4+1) \% 5 \\ &= 5 \% 5 \\ &= 0\end{aligned}$$

$$\begin{aligned}\text{Front} &= (\text{Front} + 1) \% \text{size} \\ \text{Rear} &= (\text{rear} + 1) \% \text{size}\end{aligned}$$

rear=5 new location ?

10

20



# Priority Queue

Priority Queue is a special type of queue in which elements are treated according to their priority. Insertion of an element take place at the rear of the queue but the deletion or removal of an element take place according to the priority of the element. Element with the highest priority is removed first and element with the lowest priority is removed last.



## Applications of Priority Queue

The applications of priority queue are:-

- Dijkstra's shortest path algorithm
- Data compression in huffman codes.
- Load balancing and interrupt handling in operating system.
- Sorting heap.

## How Priority is assigned?

- Priority can be assigned on the value of the element (higher value = higher priority), (lower value = higher priority)

## Operations:

- Insertion
- Deletion
- Peek

1 13 2 14 15 45 78 111

## Types of Priority Queues:

Priority = starting with digit 1

### 1. Ascending order Priority Queue

- Lower priority values get higher priority
- Eg: 4, 6, 8, 9, 10 => 4

Day1: P, S, Y

Day2: A, A, P, S

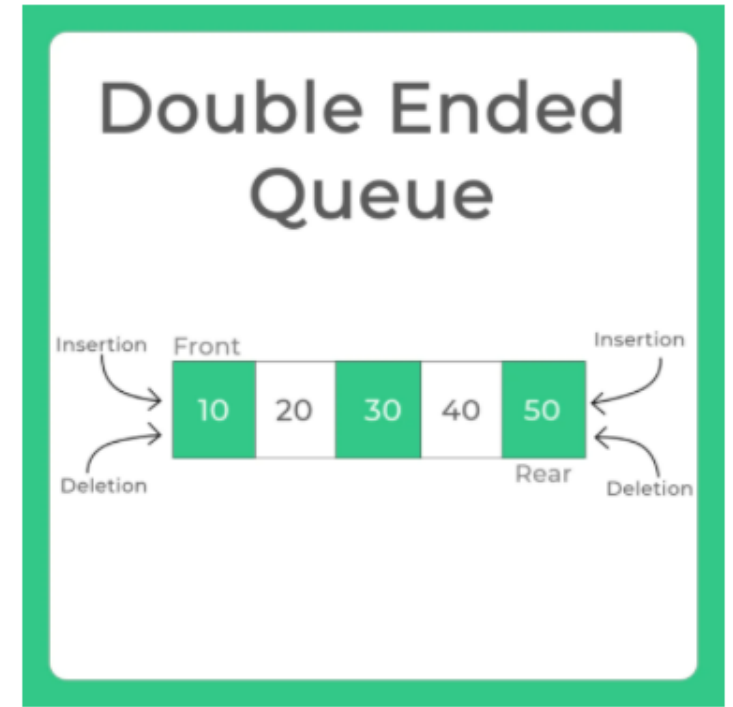
Day3: N, P, P, S



# Double Ended Queue

Double ended queue are also known as deque. In this type of queue insertion and deletion of an element can take place at both the ends. Further deque is divided into two types:-

- Input Restricted Deque :- In this, input is blocked at a single end but allows deletion at both the ends.
- Output Restricted Deque :- In this, output is blocked at a single end but allows insertion at both the ends.



## Applications of Double Ended Queue

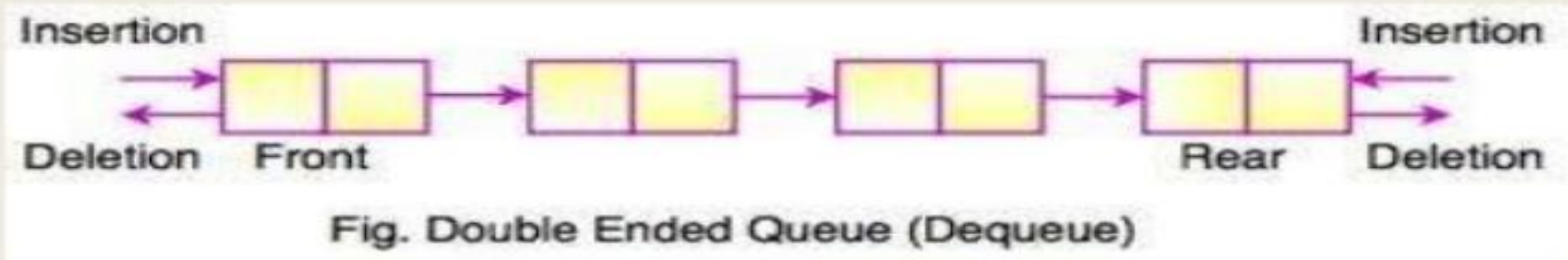
The applications of double ended queue are:-

- To execute undo and redo operation.
- For implementing stacks.
- Storing the history of web browsers.

# Deque

## (Double ended Queue)

- In Double Ended Queue, insert and delete operation can occur at both ends that is front and rear of the queue

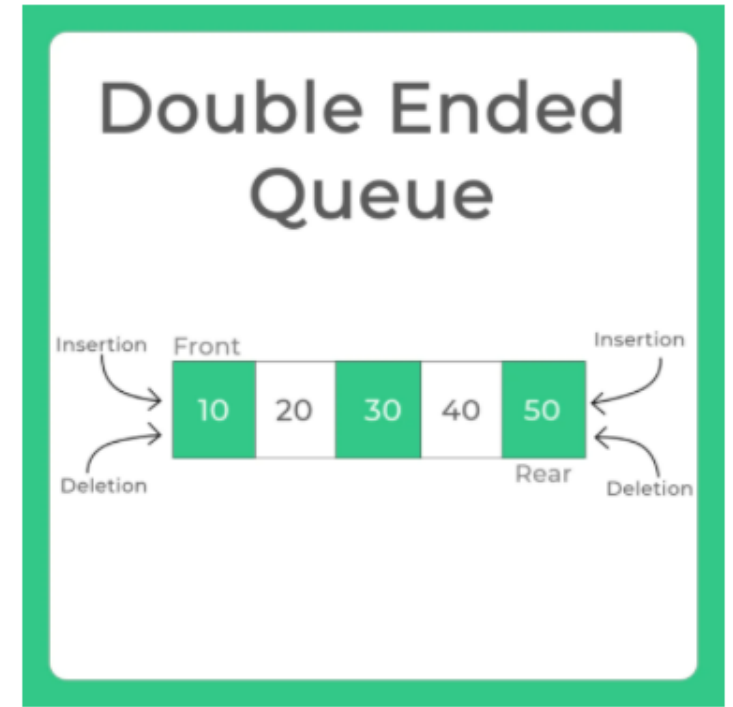




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