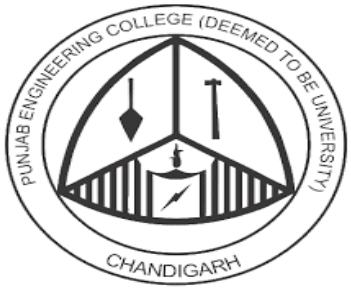
EXPLORE INNOVATE EXCEL

QUEUE

Queue: Queue Fundamentals, Application of queue

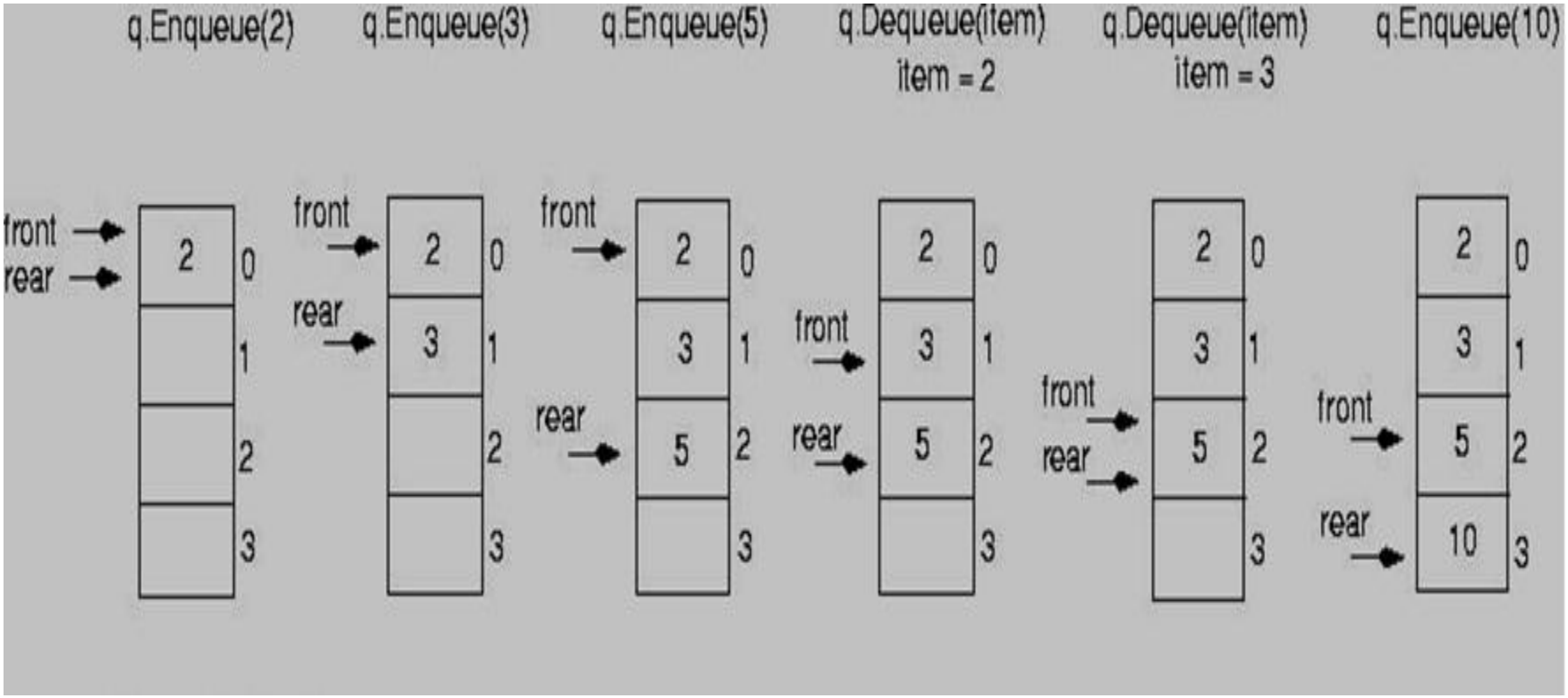


By: Dr. Mamta Kayest
Dept. of CSE, PEC Chandigarh

What is Queue?

- Stores the elements in particular way
- First In First Out (FIFO)
- Two pointers: Front and Rear
- enqueue(key): inserts the element key at Rear of queue
- dequeue(): deletes the element from front of the queue

First In First Out (FIFO)



Queue Abstract Data Type

- Main operations:
  - new() : creates a new queue
  - enqueue(Q, key): inserts element key at rear of queue Q
  - dequeue(Q): deletes element from front of queue Q
  - front(Q): returns the front element of queue Q without deleting it

- Supported operations:
  - isEmpty(Q): checks whether queue Q is empty or not
  - isFull(Q):checks whether queue Q is full or not
  - size(Q): returns the number of objects in queue Q

qinsert (queue [maxsize] , item)

This algorithm inserts an element an item at the rear of the queue(maxsize)

```
Step1   Initialization      set   front = -1
                            rear = -1
Step2   Repeat steps 3 to – until rear < maxsize – 1
Step3   Read item
Step4   If      front == -1  then
                front = 0
                rear = 0
        else
                rear = rear + 1
        endif
Step5   Set     queue [rear ] = item
Step6   Print , queue overflow
```

qdelete (queue [maxsize] , item)

This algorithm deletes an element an item at the front of the queue(maxsize)

```
Step1   Repeat steps 2 to 4 until front >= 0
Step2   Set item = queue [front]
Step3   If      front == rear  then
                set    front = -1
                set    rear = -1
        else
                       front = front + 1
Step4   Print, No. deleted is, item
Step5   Print, "Queue is empty"
```

Queue Operations

```
enqueue(Q, key)
        if (queue is not full)
                increase rear by 1
                insert key at rear

dequeue(Q)
        if (queue is not empty)
                key = delete element from front
                increase front by 1
                return (key)
```

Queue application: Job Scheduling

- Single processor and more than one job wants to execute
- More jobs are entering the system while other executing
- Once a job/process is executed, no longer required to be stored
- Eg. Printing documents using a printer
- Some strategy is required to execute all the processes

First Come First Serve (FCFS)

- The job which enters the system first, will be executed first
- Once finished execution, execute next job in the queue
- Eg. Print file1, then file2 and so on
- Implemented using a Queue

- Start executing the first job in Queue
- Insert new jobs to the end of Queue
- Once execution is done, get the next job from front and start execution of this job

Job Scheduling: Example

front	rear	Q[0]	Q[1]	Q[2]	Q[3]	Comments
-1	-1					Queue Q is empty
0	0	J1				Job J1 added to Q
0	1	J1	J2			Job J2 added to Q
1	1		J2			Job J1 deleted from Q
1	2		J2	J3		Job J3 added to Q
1	3		J2	J3	J4	Job J4 added to Q
2	3			J3	J4	Job J2 deleted from Q

Array implementation of Queue(1)

```
front ← -1;
rear ← -1;
isFull()
        if (rear = N-1)
                return true;
        else
                return false;
size()
        if (front = -1)
                return 0
        else
                return (rear + 1 – front)
isEmpty()
        if (!size() or front = rear + 1)
                return true;
        else
                return false;
```

Array Implementation of Queue(2)

enqueue(key)

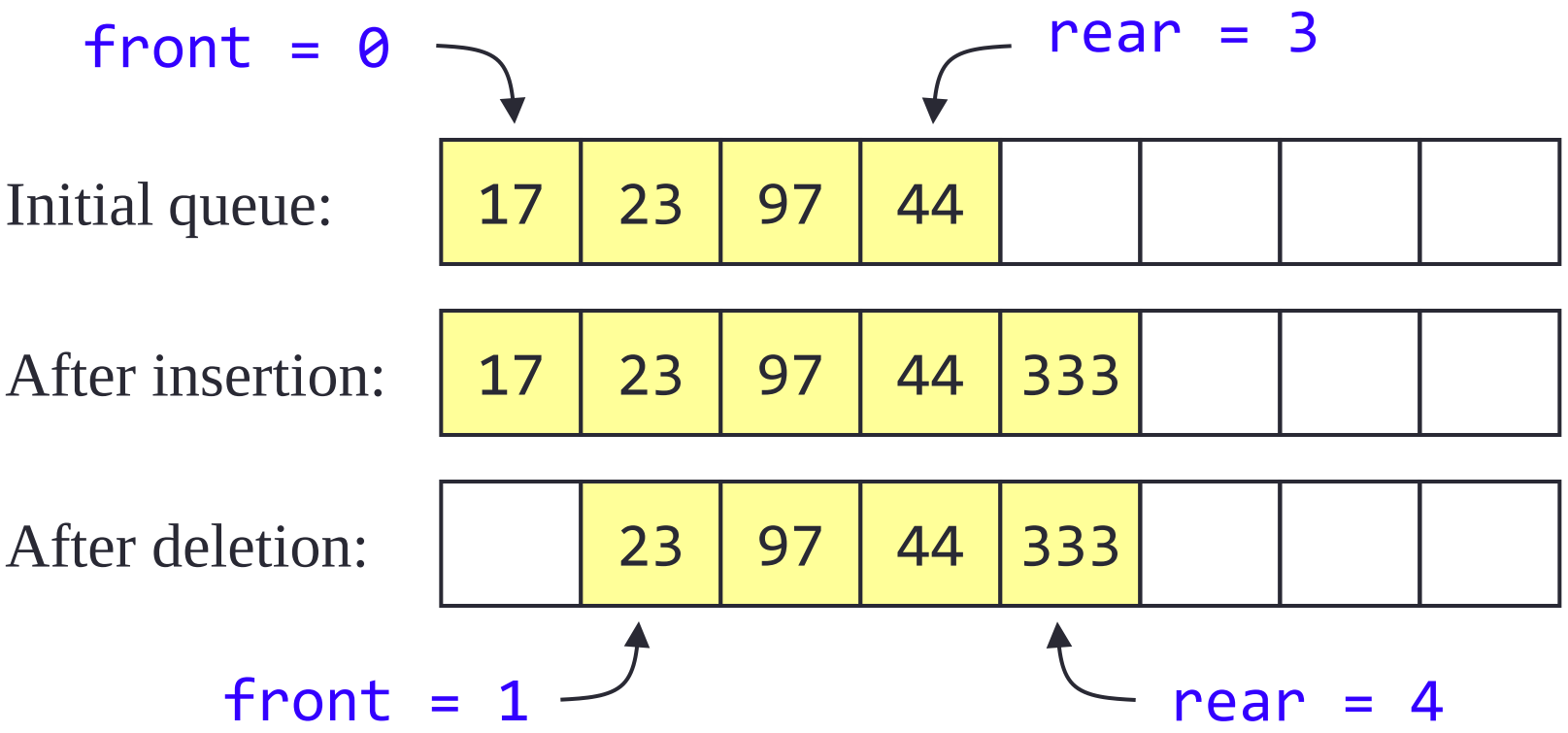
```
        if (isFull())
                "Queue is full"
        else if (front = -1)
                front ← 0;
                rear ← 0;
                Q[rear] ← key;
        else
                rear ← rear + 1;
                Q[rear] ← key;
```

Array Implementation of Queue(3)

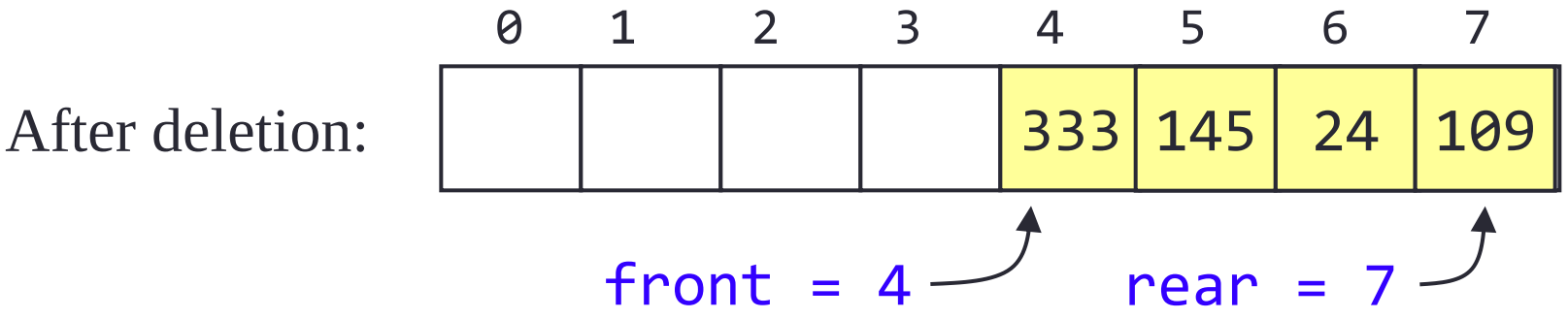
dequeue()

```
        if (isEmpty())
                "Queue is empty"
        else
                key ← Q[front]
                front ← front + 1;
                return key
```

Sample

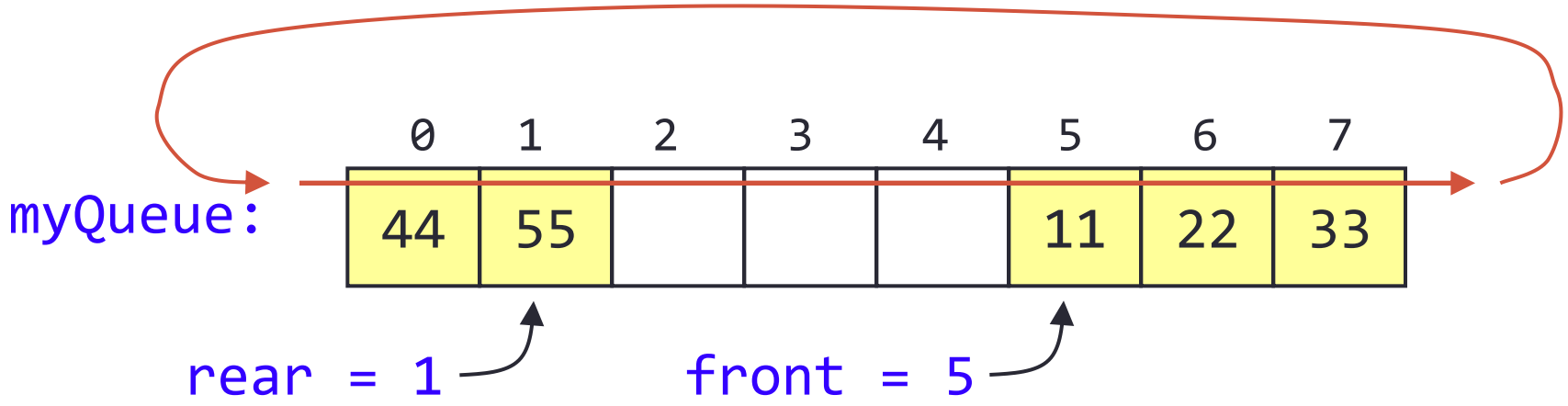

front = 0
rear = 3
Initial queue:
17
23
97
44
After insertion:
17
23
97
44
333
After deletion:
23
97
44
333
front = 1
rear = 4

Issue with Implementation



- Problem: Even if space is available, can't insert the objects in queue
- Solution: circular queue

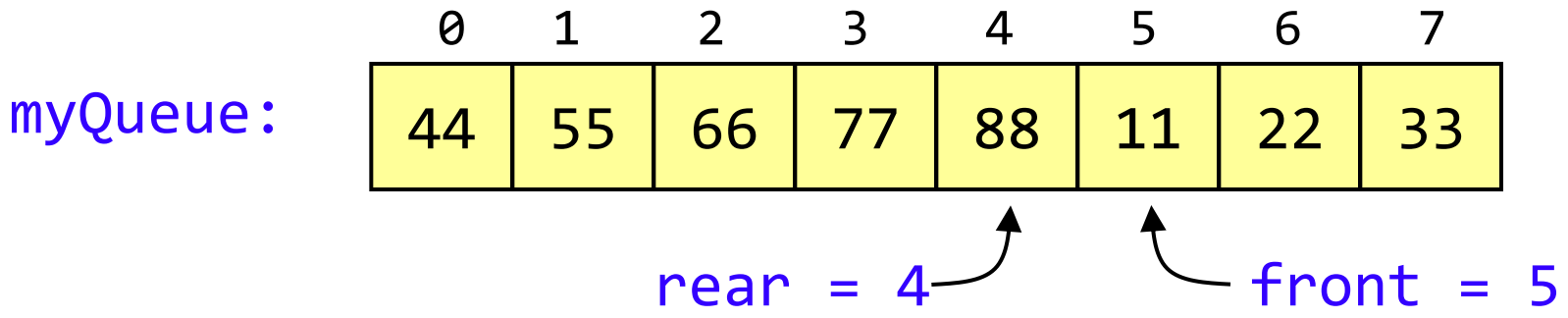
Circular Queue



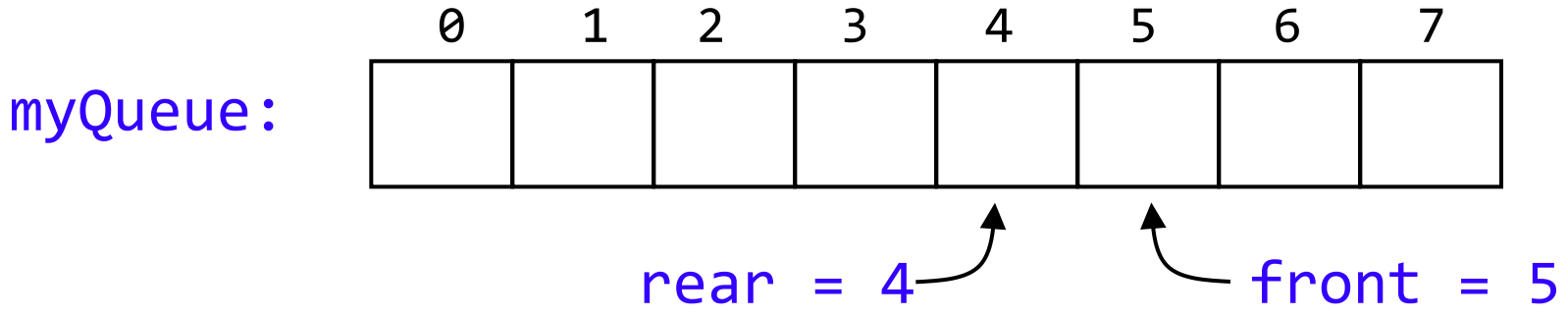
- Once end of array is reached, start inserting/deleting from the beginning of array
- Updated dequeue: `front = (front + 1) % length;`
- updated enqueue: `rear = (rear + 1) % length;`

Full and empty queues

- If the queue were to become completely full, it would look like this:

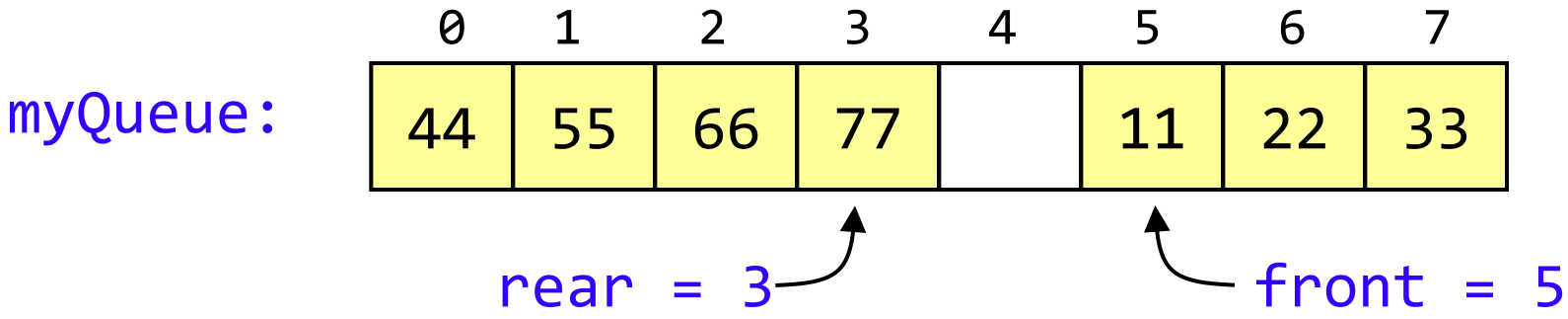


- If we were then to remove all eight elements, making the queue completely empty, it would look like this:



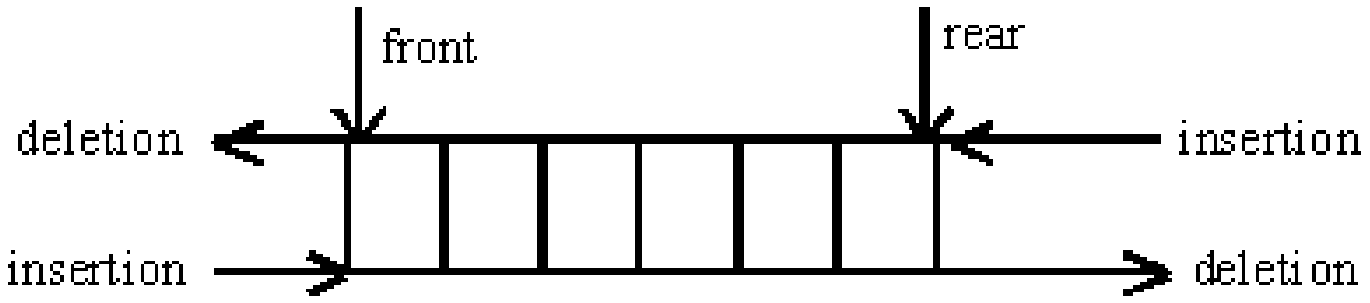
Issue with Implementation

- Problem: Both full and empty queue has same front and rear values
- Solution: consider queue full when it has n-1 elements



Double Ended Queue(Deque)

- Insertion and deletion can happen at both ends of the queue
- Separate function for insertion and deletion from front and rear



Implementation of Deque

```
insert_F(queue Q, int data) {  //insert in front of queue
        if (Q is full)
                print (“overflow”);
        else
                front = front-1;
                Q[front] = data; }

delete_F(queue Q) {  //delete from front of queue
        if (Q is empty)
                print (“underflow”);
        else
                temp = Q[front];
                front = front +1;
                return temp; }
```

Implementation of Deque

```
insert_R(queue Q, int data) {  //insert in rear of queue
        if (Q is full)
                print (“overflow”);
        else
                rear = rear + 1;
                Q[rear] = data; }

delete_R(queue Q) {  //delete from rear of queue
        if (Q is empty)
                print (“underflow”);
        else
                temp = Q[rear];
                rear = rear - 1;
                return temp; }
```

Versions of Deque

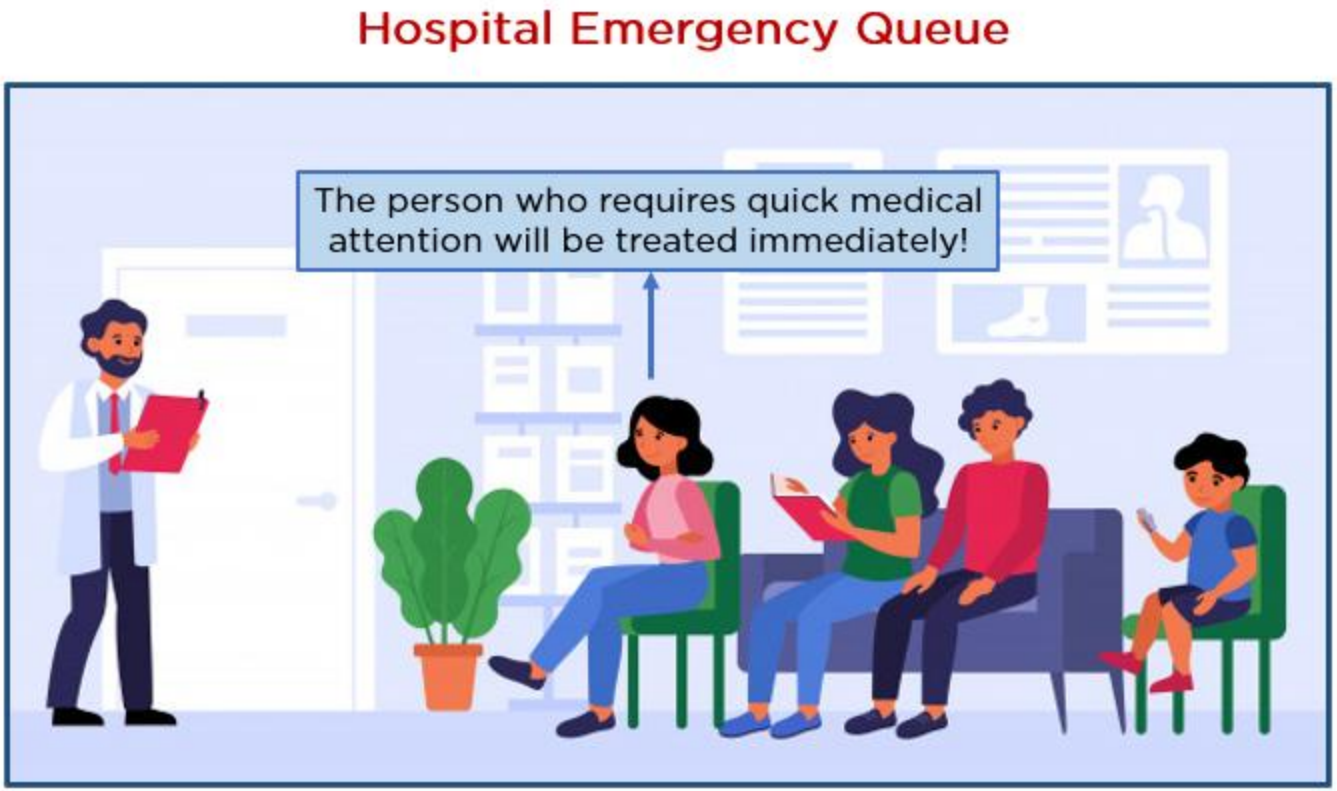
- **Input restricted Deque:** deletion can be made from both ends, but insertion can be made at one end only.
- Application: Web Browser History

- **Output restricted Deque:** insertion can be made at both ends, but deletion can be made from one end only.

Priority Queue

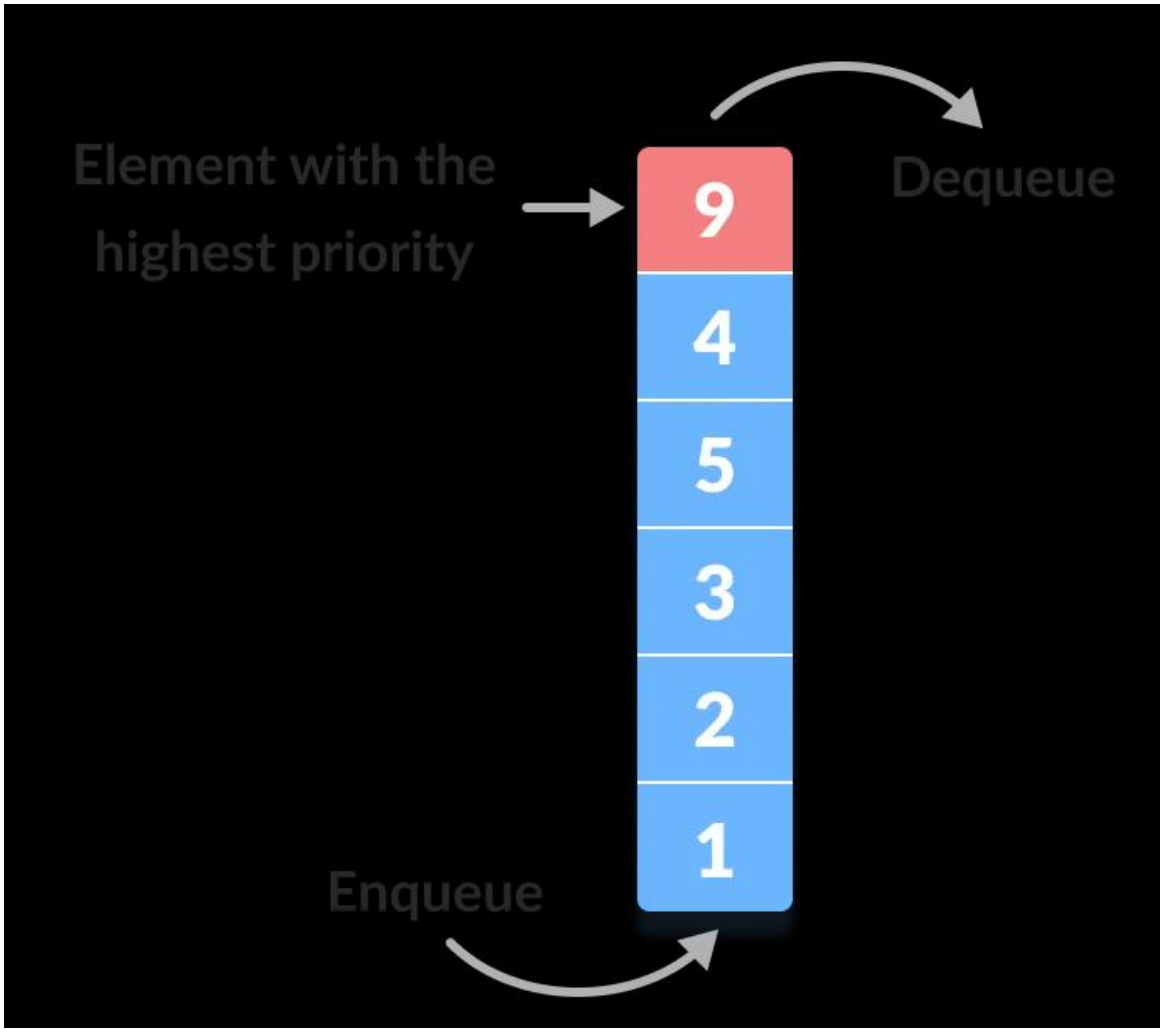
- Priority Queue is an extension of queue with following properties:
  - Every item has a priority associated with it.
  - An element with high priority is dequeued before an element with low priority.
  - If two elements have the same priority, they are served according to their order in the queue.

Example of Priority Queue



Difference between Priority Queue and Normal Queue

- In a queue, the **first-in-first-out rule** is implemented whereas, in a priority queue, the values are removed **on the basis of priority**. The element with the highest priority is removed first.


Element with the highest priority
9
4
5
3
2
1
Dequeue
Enqueue

Thanks