



## QUEUE

↳ FIFO

(First In First Out)

### Queue ADT

Data: (1) Space for storing elements  
(2) Front : for deletion  
(3) Rear : for insertion

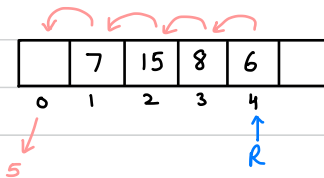
Operations: (1) enqueue(x)  
(2) dequeue()  
(3) isEmpty()  
(4) isFull()  
(5) first()  
(6) last()

- (1) Array
- (2) Linked List

### QUEUE USING ARRAY

1. Queue using single pointer
2. Queue using front and rear.
3. Drawbacks of queue using array.

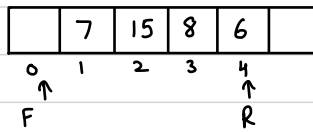
#### 1. Queue using single pointer



Insert -  $O(1)$

Delete -  $O(n)$

## 2. Queue using front and rear



initially  $\text{front} = \text{rear} = -1$

Insertion: increment rear and insert  $O(1)$

Deletion: increment front and delete  $O(1)$

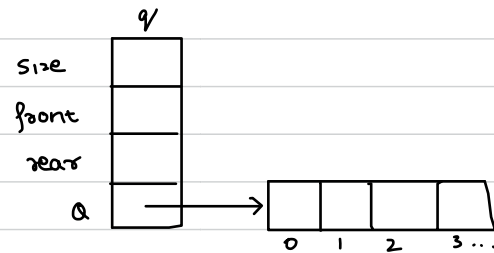
Empty: if ( $\text{front} == \text{rear}$ )

Full: if ( $\text{rear} = \text{Size} - 1$ )

### PROGRAM FOR QUEUE USING ARRAY

Struct Queue

```
{
    int size;
    int front;
    int rear;
    int *Q;
}
```



```
int main ()
{
```

```
    Struct Queue q;
    printf("Enter Size: ");
    scanf("%d", &q.size);
    q.Q = new int[q.size];
    q.front = q.rear = -1;
}
```

```
void enqueue (Queue *q, int x)
{
```

```
    if (q->rear == q->size-1)
        printf("Queue is full");
    else
    {
        q->rear++;
        q->Q[q->rear] = x;
    }
}
```

```
void dequeue (Queue *q)
{
```

```
    int x = -1;
```

```
    if (q->front == q->rear)
        printf("Queue is empty");
    else
    {
```

```
        q->front++;
        x = q->Q[q->front];
    }
    return x;
}
```

### DRAWBACK OF QUEUE USING ARRAY

- |   |   |   |   |   |   |
|---|---|---|---|---|---|
|   |   |   |   |   |   |
| 0 | 1 | 2 | 3 | 4 | 5 |
- ↑↑  
 F R

### USING SPACE AGAIN SOLUTION

### (1) Resetting Pointers

Whenever Front and Rear are pointing at same place, initialize them as -1

## (2) Circular Queue

In circular queue, front and rear initialize with array's first position.

```

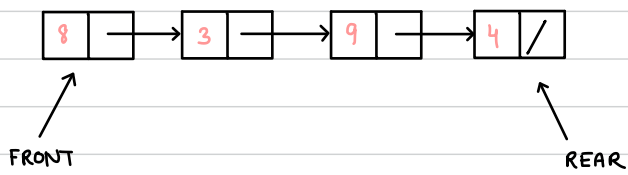
void enqueue(struct Queue *q, int x)
{
    if ((q->Rear+1)%q->Size == q->Front)
        printf("Queue is Full");
    else
    {
        q->Rear = (q->Rear + 1) % q->Size;
        q->Q[q->Rear] = x;
    }
}

```

year	year + 1	% Size
0	(0 + 1)	%. 7 = 1
1	(1 + 1)	%. 7 = 2
2	(2 + 1)	%. 7 = 3
3	(3 + 1)	%. 7 = 4
4	(4 + 1)	%. 7 = 5
5	(5 + 1)	%. 7 = 6
6	(6 + 1)	%. 7 = 0

```
void dequeue ( struct Queue *q)
{
    int x = -1
    if ( q → front == q → rear)
        printf (" Queue is Empty ");
    else
    {
        q → front = (q → front + 1) % q → size;
        x = q → Q [ q → front ];
    }
    return x;
}
```

## QUEUE USING LINKED LIST



Empty : if (front == NULL)

Full : Node \*t = new Node;  
if (t == NULL)

// No more nodes can be created  
i.e heap is full

```
void enqueue (int x)    O(1)
{
```

```
    Node *t = new Node;
```

```
    if (t == NULL)
```

```
        printf("Queue is Full");
```

```
    else
```

```
    {
```

```
        t->data = x;
```

```
        t->next = NULL;
```

```
        if (front == NULL)
```

```
            front = rear = t;
```

```
        else
```

```
        {
```

```
            rear->next = t
```

```
            rear = t;
```

```
        }
```

```
    }
```

```
}
```

```
int dequeue()    O(1)
{
```

```
    int x = -1;
```

```
    Node *p;
```

```
    if (front == NULL)
```

```
        printf("Queue is Empty");
```

```
    else
```

```
    {
```

```
        p = front;
```

```
        front = front->next;
```

```
        x = p->data;
```

```
        free(p);
```

```
    }
```

```
    return x;
```

```
}
```

## DE Queue

↳ Double Ended Queue

### QUEUE

	Insert	Delete
front	x	✓
rear	✓	x

### DEQUEUE

	Insert	Delete
front	✓	✓
rear	✓	✓

### INPUT RESTRICTED DEQUEUE

	Insert	Delete
front	x	✓
rear	✓	✓

### OUTPUT RESTRICTED DEQUEUE

	Insert	Delete
front	✓	✓
rear	✓	x

## PRIORITY QUEUES

1. Limited Set of priorities
2. Element Priority

### 1. Limited Set of priorities

Priorities = 3

Element	→	A	B	C	D	E	F	G	H	I	J
Priority	→	1	1	2	3	2	1	2	3	2	2

### Priority Queues

Q <sub>1</sub>	A	B	F			
Q <sub>2</sub>	C	E	G	I	J	
Q <sub>3</sub>	D	H				

INSERTION

### DELETION

For deletion, elements of Q<sub>1</sub> will be deleted first, then Q<sub>2</sub> and then Q<sub>3</sub>

Elements will be deleted in FIFO

## 2. Element Priority

Elements  $\rightarrow$  6, 8, 3, 10, 15, 2, 9, 17, 5, 8

- Element is itself a priority
- Smaller number higher priority

1. Insert in same order  $O(1)$   
Delete max priority by searching it  $O(n)$

2. Insert in increasing order of priority  $O(n)$   
Delete the last element of array  $O(1)$

## QUEUE using 2 STACKS

assume stacks to be  
implemented using linked  
list

```
enqueue(int x)
{
    push(&s1, x);
}
```

```
int dequeue()
{
    int x = -1;
    if (isEmpty(s2))
    {
        if (isEmpty(s1))
        {
            printf("Queue Empty");
            return x;
        }
        else
        {
            while (!isEmpty(s1))
                push(&s2, pop(&s1));
        }
    }
    return pop(&s2);
}
```

