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Fundamentals of Data Structures

S. Y. B. Tech CSE

Trimester – III

SCHOOL OF COMPUTER ENGINEERING AND TECHNOLOGY

Queue

Topics to be Covered

❑ Queue as an Abstract Data Type

❑ Representation of Queue Using Sequential Organization

❑ Applications of Queue

Unit : V

Queue

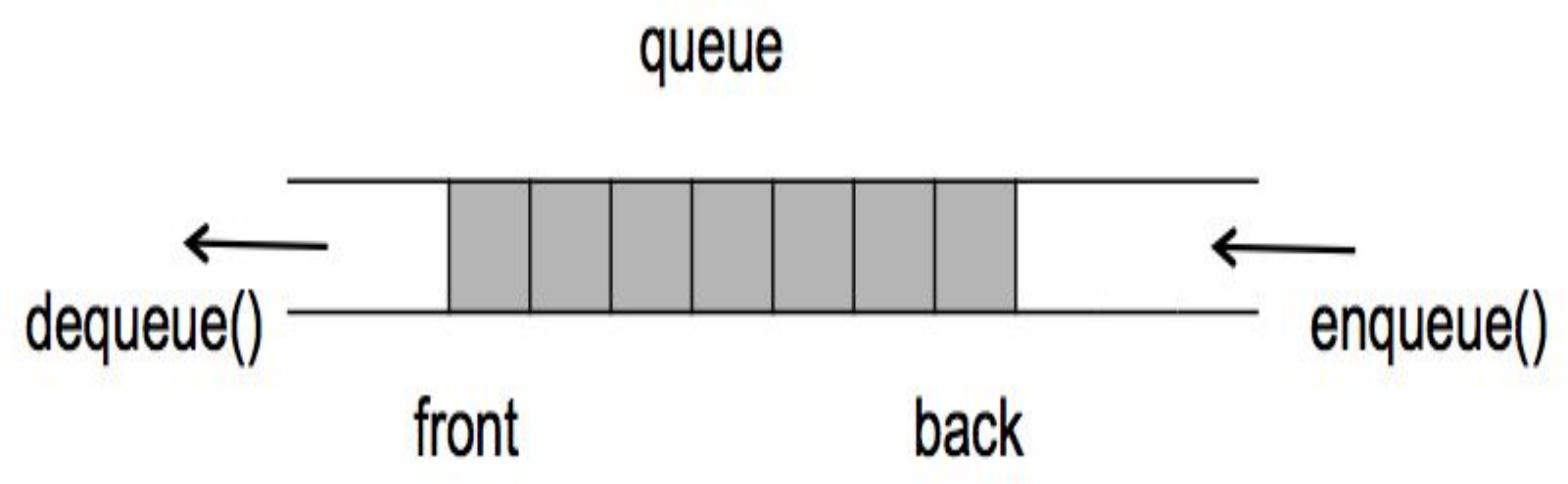
Queue

Queue as a Data Structure

Rear of Queue
Front of Queue
next...
PAY HERE

Queue

Queue is an ordered list (linear data structure) in which insertions(Enqueue) are done at rear end and deletions(dequeue) are done at the front end of the Queue.



ADT of Queue

CREATEQ(*Q) which creates Q as an empty queue;*

ADDQ(*i,Q) which adds the element i to the rear of a queue and returns the new queue;*

DELETEQ(*Q) which removes the front element from the queue Q and returns the resulting queue;*

FRONT(*Q) which returns the front element of Q;*

ISEMTQ(*Q) which returns true if Q is empty else false.*

ADT of Queue (Cont’)

A complete specification of this data structure is

structure *QUEUE (item)*

1 **declare *CREATEQ( ) queue***

2 *ADDQ(item,queue) □queue*

3 *DELETEQ(queue) □queue*

4 *FRONT(queue) □item*

5 *ISEMTQ(queue) □boolean;*

```
6 for all Q queue, i item let
ISEMTQ(CREATEQ) :: = true
ISEMTQ(ADDQ(i,Q)) :: = false
DELETEQ(CREATEQ) :: = error
DELETEQ(ADDQ(i,Q)):: =
        if ISEMTQ(Q) then CREATEQ
        else ADDQ(i,DELETEQ(Q))
FRONT(CREATEQ) :: = error
FRONT(ADDQ(i,Q)) :: =
        if ISEMTQ(Q) then i else FRONT(Q)
16 end
17 end QUEUE
```

Applications of Queue

- Queues, like stacks, also arise quite naturally in the computer solution of many problems.
- The most common occurrence of a queue in computer applications is for the scheduling of jobs.
- In batch processing the jobs are "queued-up" as they are read-in and executed, one after another in the order they were received.

Operations on Queue

- Adding an element at the rear of the Queue
- Delete the front element from the queue
- PeepRear returns the rear element of the queue
- PeepFront returns the front element of the queue
- isFull returns if queue is full
- isEmpty returns if queue is empty

Adding a element

```
Algorithm AddQ(q[],elem)
{
          if(isfull())
            print "Queue is full "
         else
          {  rear=rear+1
              q[rear]=elem
          }
 }
```

```
int  isfull()
{      if(rear==size-1)
             return  1
       else
            return  0
}
```

Deleting an element from Queue

```
Algorithm DelQ(q[])
{
        if(isempty())
              return -1
       else
        {       front=front+1
                elem=q[front]
                return elem
        }
 }
```

```
int  isempty()
{     if(rear==front)
          return 1
      else
          return  0
}
```

Queue operations

AddQ(10)

AddQ(18)

E=delQ()

AddQ(20)

E=delQ()

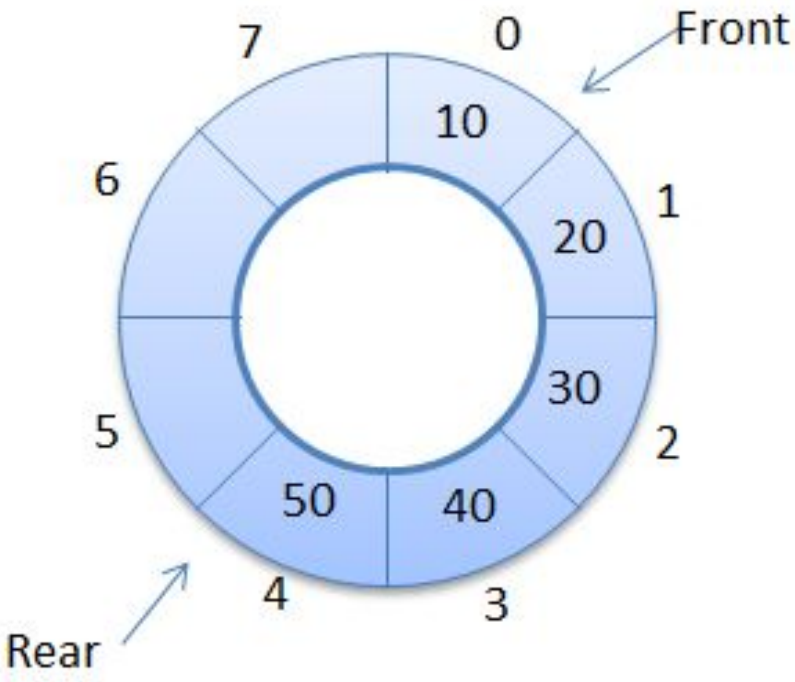
E=delQ()

E=delQ()

Circular Queue

- A more efficient queue representation is obtained by regarding the array *Q(1:n) as circular. It now* becomes more convenient to declare the array as *Q(0:n - 1).*
- *When rear = n - 1, the next element is* entered at *Q(0) in case that spot is free. Using the same conventions as before, front will always point* one position counterclockwise from the first element in the queue.

Circular Queue



Circular Queue

Initially front=rear=0

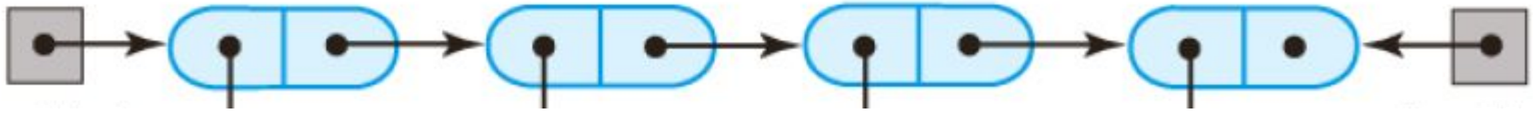
```
Algorithm AddCQ(elem)
{  //insert items in the CQ stored in Q[0..n-1]
   //rear points to the last item & front is one
   //position counter clockwise  from the first
    if (rear +1 ) %n== front
           print “queue full”
      else
      {    rear=(rear+1) %n
         Q[rear]=elem
       }
}
```

Circular Queue

Initially front=rear=0

```
Algorithm DelCQ(elem)
{  //removes the front element of the queue
    if front==rear
       print “queue empty”
    else
    {  front=(front+1) %n
        elem=Q[front]
        return elem
   }
}
```

Linked Queue and Operations



front

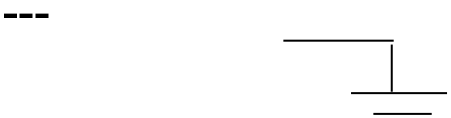
rear

Queue implemented using Singly linked list

Linked Queue and Operations

Empty queue will have front and rear with the following conditions:

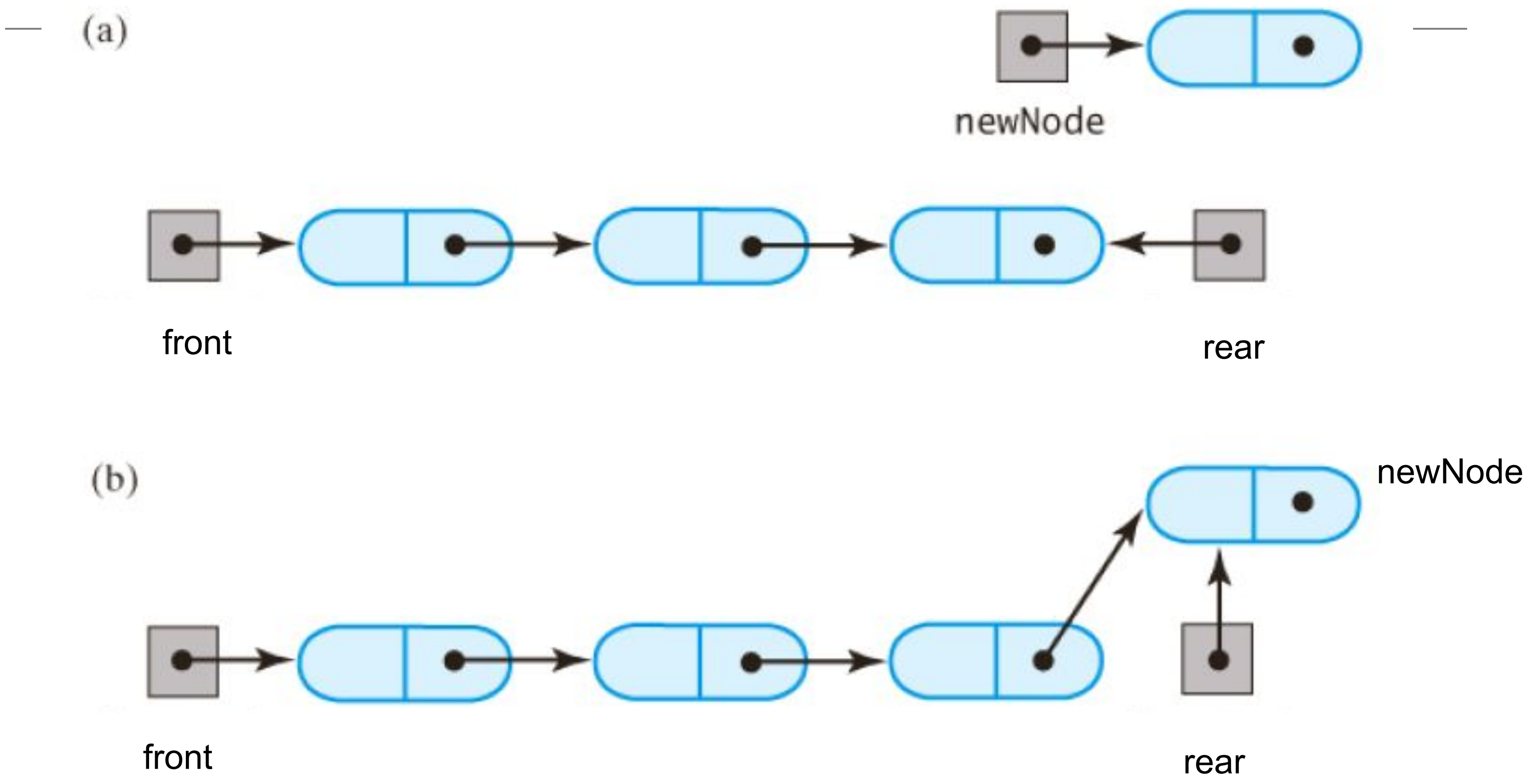
front->next=NULL
rear=NULL



```
rear = NULL;
```

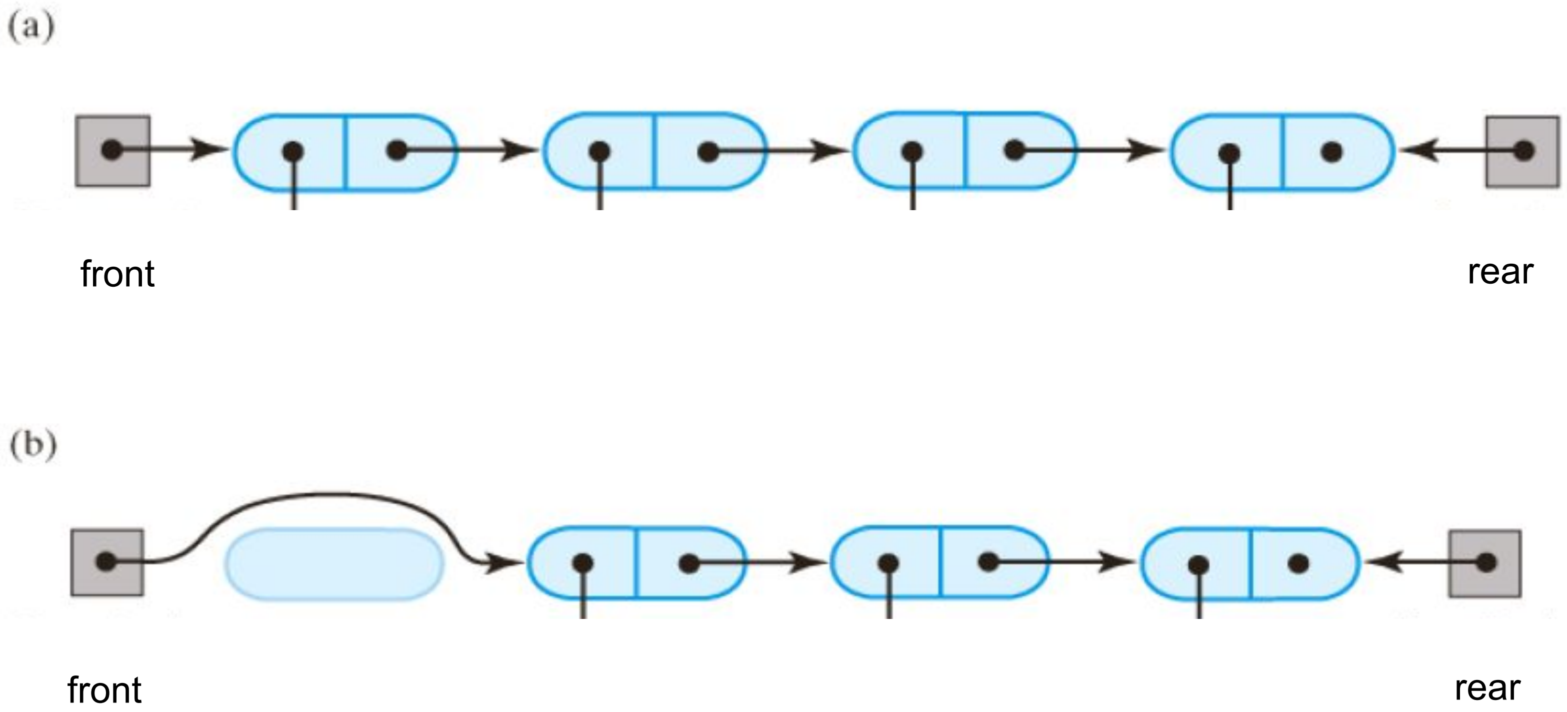
front

Linked Queue and Operations



Enqueue operation: a) New node created b) New node inserted (Enqueue complete)

Linked Queue and Operations



Dequeue operation: a) Before deletion b) First node deleted (Dequeue complete)

Linked Queue and Operations

```
struct node
{
        int data;
        struct node *next;
};
struct node *front, *rear;
//following statements to be
initialized in main
front=(struct node *)
    malloc(sizeof(struct node));
front->next=NULL;
rear=NULL;
```

```
int isempty()
{
    if(front->next==NULL)
        return 1;
    else
        return 0;
}
```

Linked Queue and Operations

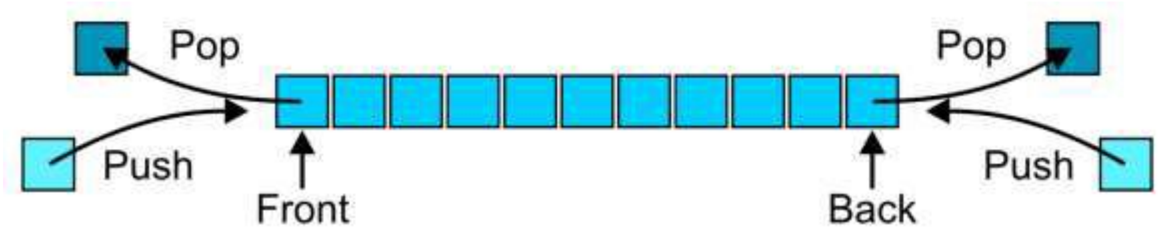
```
void enqueue(int element )
{
  //allocate memory to new_node
    new_node->data=element;
    new_node->next=NULL;
    if(isempty())
    {
        front->next=rear=new_node;
    }
    else
    {
        rear->next=new_node;
        rear=new_node;
    }
}
```

Linked Queue and Operations

```
int dequeue()
{
     if(isempty())
     {
            //print queue is empty
            return -1;
     }
     else
              {
                     temp = front->next;
                     value = temp->data;
                     front->next=temp->next;
                     temp->next=NULL;
                     free(temp);
                     return (value);
              }
}
```

Double Ended Queue(Deque)

- A double-ended queue (deque) is an abstract data type that generalizes a queue, for which elements can be added to or removed from either the front or rear.
- Hybrid linear structure provides all the capabilities of stacks and queues in a single data structure.



Types of deque

- Input-restricted deque

Deletion can be made from both ends, but Insertion can be made at one end only.

- Output-restricted deque

Insertion can be made at both ends, but Deletion can be made from one end only.

deque Operations

- pushRear() - Insert element at back
- pushFront() - Insert element at front
- popRear() - Remove last element
- popFront() - Remove first element
- isEmpty() – Checks whether the queue is empty or not.

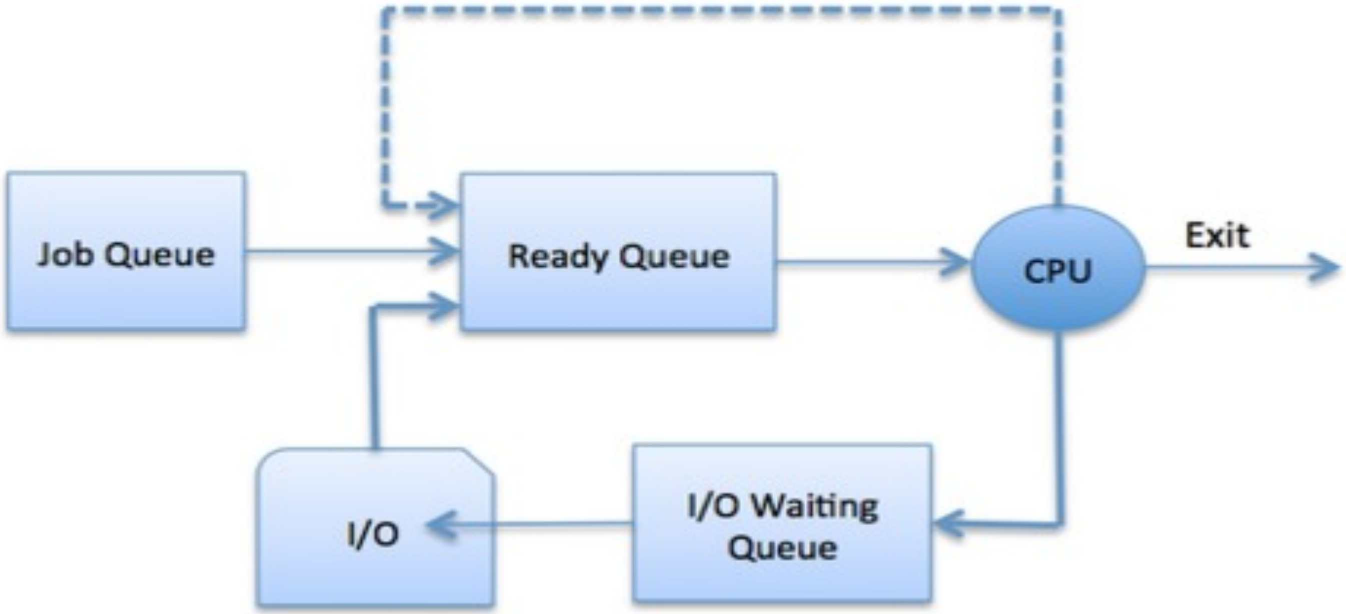
deque Example

Operation	Deque content
pushFront(‘a’)	[‘a’]
pushFront(‘b’)	[‘b’ , ‘a’]
pushRear(‘c’)	[‘b’ , ‘a’ , ‘c’]
popFront()	[‘a’ , ‘c’]
popRear()	[‘a’]

Queue Applications: Job Scheduling

- Job scheduling is the process of allocating system resources to many different tasks by an operating system (OS).
- The system handles prioritized job queues that are awaiting CPU time and it should determine which job to be taken from which queue and the amount of time to be allocated for the job.
- This type of scheduling makes sure that all jobs are carried out fairly and on time.
- Job scheduling is performed using job schedulers. Job schedulers are programs that enable scheduling and, at times, track computer "batch" jobs, or units of work

- The Operating System maintains the following important process scheduling queues −
- **Job queue** − This queue keeps all the processes in the system.
- **Ready queue** − This queue keeps a set of all processes residing in main memory, ready and waiting to execute. A new process is always put in this queue.
- **Device queues** − The processes which are blocked due to unavailability of an I/O device constitute this queue.



FAQS

1. Write an ADT for Queue
2. What are the primitive operations of Queue.
3. Explain with example Queue applications.

Takeaways

- ❑ Queue is First in First Out(FIFO) Data Structure
- ❑ Primitive operations on Queue are enqueue, dequeue,isEmpty and isFull
- ❑ Queue can be represented by using Array as well as linked list.
- ❑ Queue is commonly used in Job Sequencing by OS.