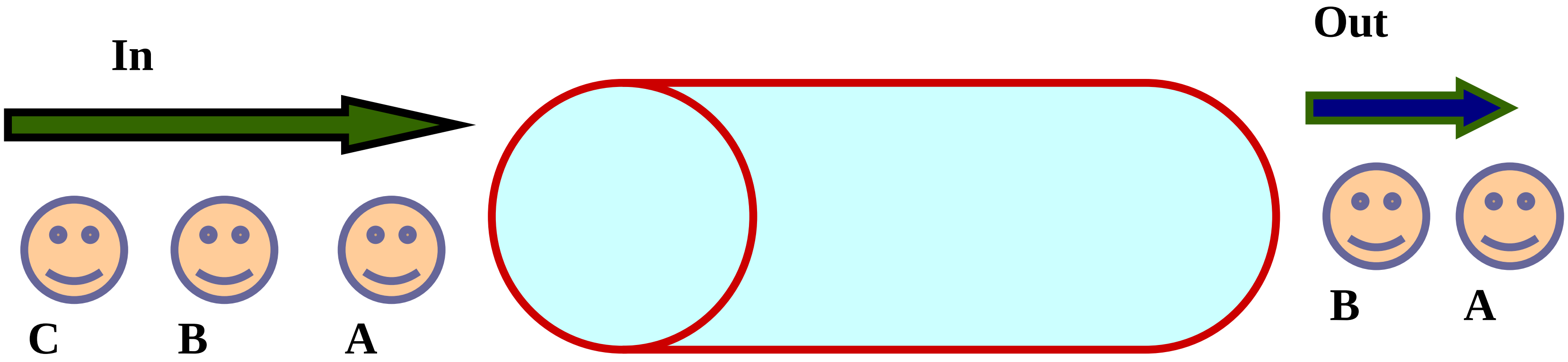
Stack and Queue

Queue

Data structure with First-In First-Out (FIFO) behavior



Typical Operations on Queue

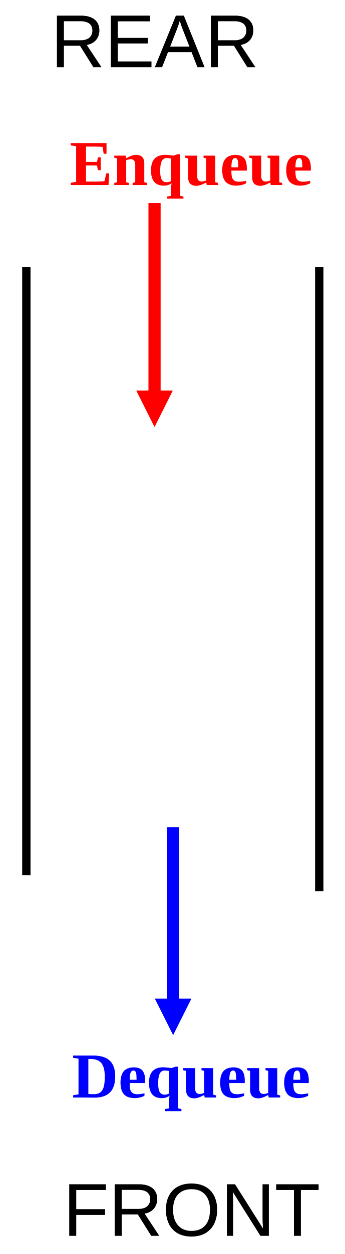
isempty: determines if the queue is empty

isfull: determines if the queue is full in case of a bounded size queue

front: returns the element at front of the queue

enqueue: inserts an element at the rear

dequeue: removes the element in front



REAR

Enqueue

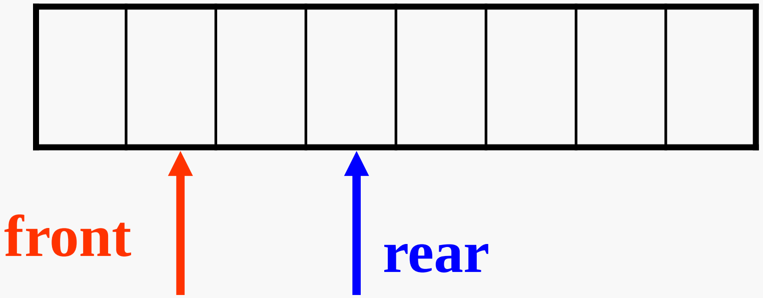
Dequeue

FRONT

Possible Implementations

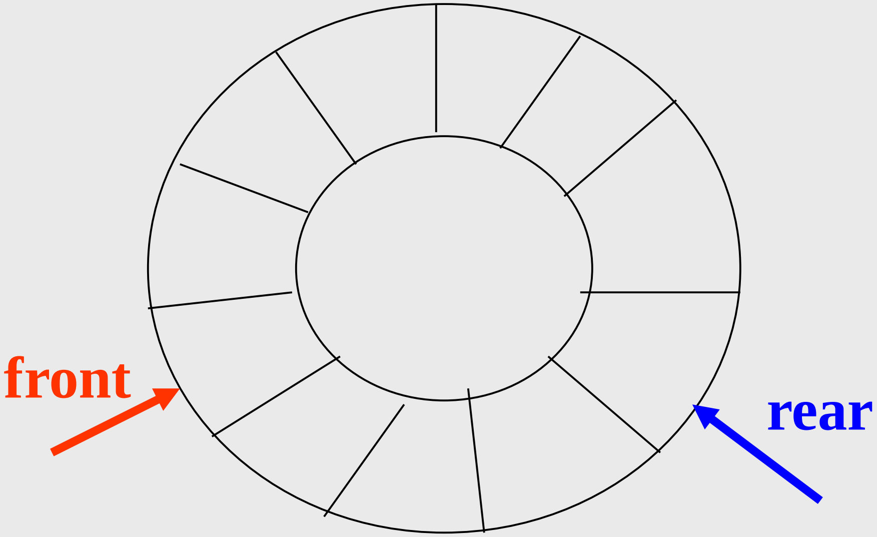
Linear Arrays:

(static/dynamicaly allocated)



Circular Arrays:

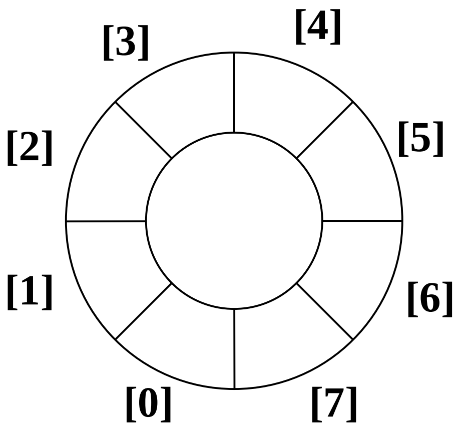
(static/dynamically allocated)



Can be implemented by a 1-d array using modulus operations

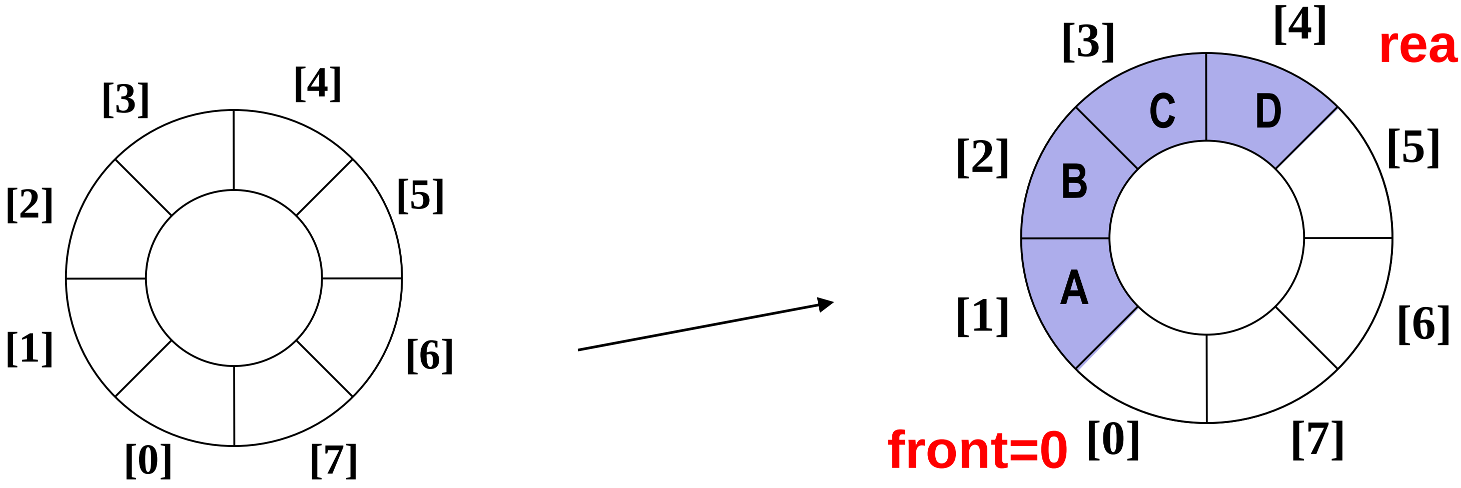
Linked Lists: **Use a linear linked list with insert_rear and delete_front operations**

Circular Queue



front=0
rear=0

Circular Queue



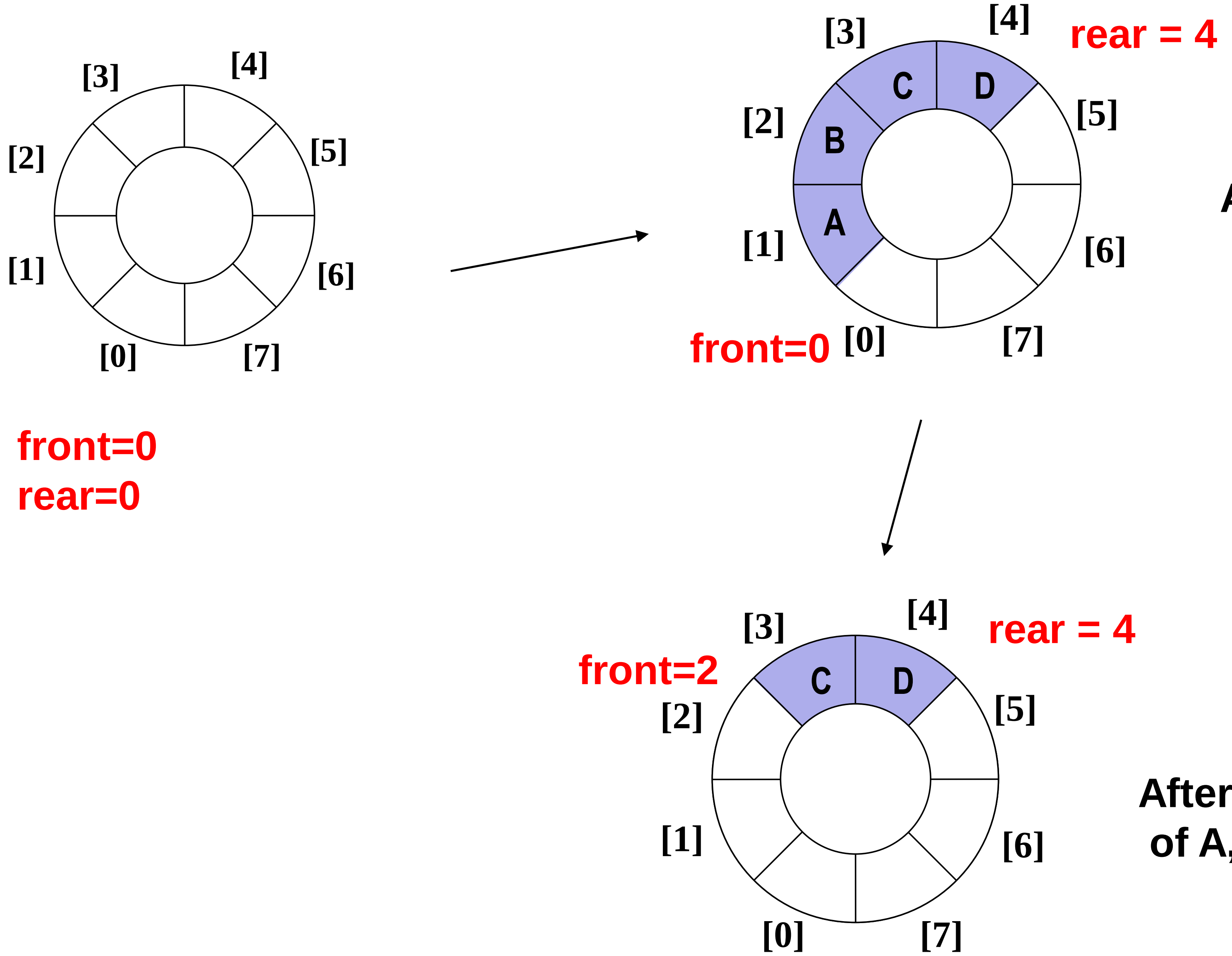
rear = 4

front=0

After insertion of A, B, C, D

front=0
rear=0

Circular Queue



front=0
rear=0

rear = 4

front=0

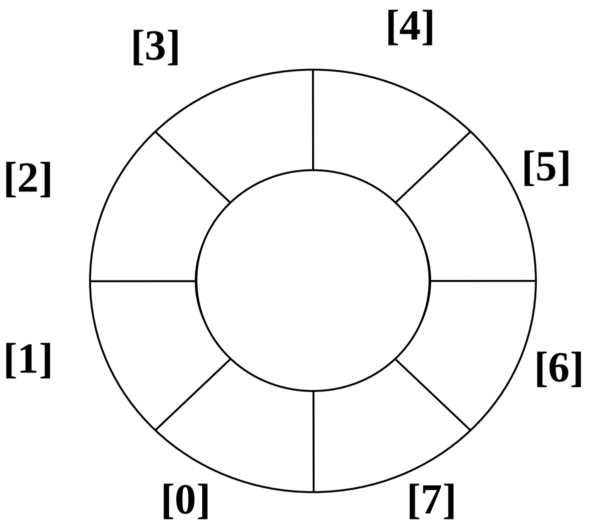
After insertion of A, B, C, D

front=2

rear = 4

After deletion of of A, B

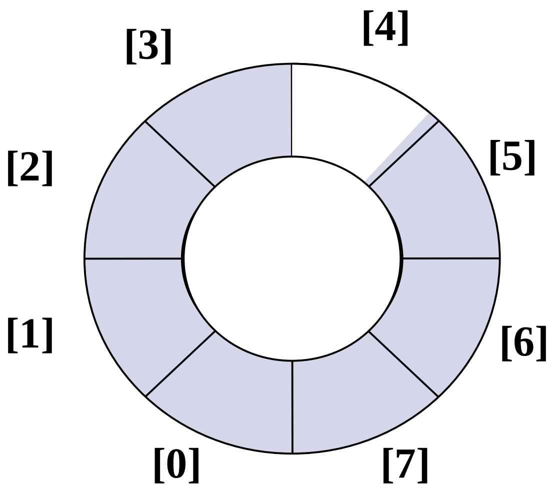
front: index of queue-head (always empty)
rear: index of last element, unless rear = front



front=0
rear=0

Queue Empty

rear = 3
front=4



Queue Full

Queue Empty Condition: ***front == rear***
Queue Full Condition: ***front == (rear + 1) % MAX_Q_SIZE***

Creating and Initializing a Circular Queue

Declaration

```
#define MAX_Q_SIZE 100
typedef struct {
    int key; /* just an example, can have
                 any type of fields depending
                 on what is to be stored */
}  element;
typedef struct {
    element list[MAX_Q_SIZE];
    int front, rear;
 } queue;
```

Create and Initialize

```
queue Q;
Q.front = 0;
Q.rear = 0;
```

Operations

```
int isfull (queue *q)
{
    if (q->front == ((q->rear + 1) %
                              MAX_Q_SIZE))
          return 1;
    return 0;
}
```

```
int isempty (queue *q)
{
    if (q->front == q->rear)
        return 1;
    return 0;
}
```

Operations

```
element front( queue *q )
 {
     return q->list[(q->front + 1) % MAX_Q_SIZE];
 }
```

```
void enqueue( queue *q, element e)
 {
    q->rear = (q->rear  + 1)%
                          MAX_Q_SIZE;
    q->list[q->rear] = e;
 }
```

```
void dequeue( queue *q )
 {
    q-> front =
            (q-> front + 1)%
                        MAX_Q_SIZE;
 }
```

Practice Problems

- Implement the Queue as a linked list.
- Implement a Priority Queue which maintains the items in an order (ascending/ descending) and has additional functions like remove_max and remove_min
- Maintain a Doctor’s appointment list