Queues

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Fall 2024

Outline

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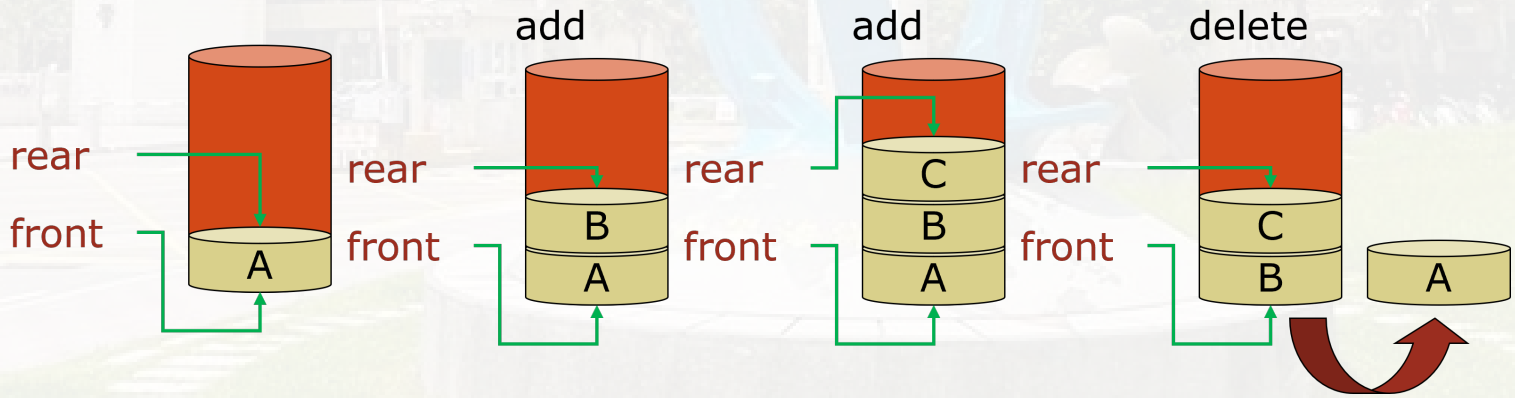
Definition

- A queue is an ordered list in which insertions take place at one end (i.e., front) and deletions take place at the opposite end (i.e., rear).
  - insertions: push/add
  - deletions: pop/remove
- First-In-First-Out (FIFO).



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Functions for Queues

- Create a queue (implemented by an array).
  - Create an empty queue with maximum size `MAX_QUEUE_SIZE`.

```
#define MAX_QUEUE_SIZE 100

typedef struct {
    int key; // can be of other types...
    /* other fields? */
} element;

element queue a[MAX_QUEUE_SIZE];
int front = -1; // initially no element
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```

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- IsFull
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    rear == MAX_QUEUE_SIZE-1;
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- Enqueue (or AddQ)
  - Insert the element into the rear of the queue.

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- Enqueue (or AddQ)
  - Insert the element into the rear of the queue.
    If the queue is not full, `queue[++rear] = element;`
- Dequeue (or DeleteQ)
  - Remove and return the item at the front of the queue.

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- Enqueue (or AddQ)
  - Insert the element into the rear of the queue.
    If the queue is not full, `queue[++rear] = element;`
- Dequeue (or DeleteQ)
  - Remove and return the item at the front of the queue.
    If the queue is not empty, `return stack[++front];`

addQ or Enqueue

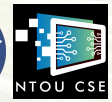
```
void Enqueue(element item) { // add item to the queue
    if (rear == MAX_QUEUE_SIZE - 1) {
        queueFull();
    }
    queue[++rear] = item;
}

void queueFull() {
    fprintf(stderr, "Queue is FULL!!");
    exit(EXIT_FAILURE);
}
```

delteQ or Dequeue

```
element Dequeue() { // no argument is required!
    if (front == rear) {
        return queueEmpty(); // return an error
    }
    return queue[++front];
}

element queueEmpty() {
    element errKey; // depending the struct of element
    errKey.key = -99;
    fprintf(stderr, "Queue is EMPTY!!");
    return errorKey;
}
```

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Job Scheduling

front	rear	Q[0]	Q[1]	Q[2]	Q[3]	comments
-1	-1					queue is empty
-1	0	J_1				Job J_1 is added
-1	1	J_1	J_2			Job J_2 is added
-1	2	J_1	J_2	J_3		Job J_3 is added
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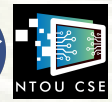
- We should move the ENTIRE queue to the left. $\Rightarrow$ $O(MAX\_QUEUE\_SIZE)$ (very time consuming!)

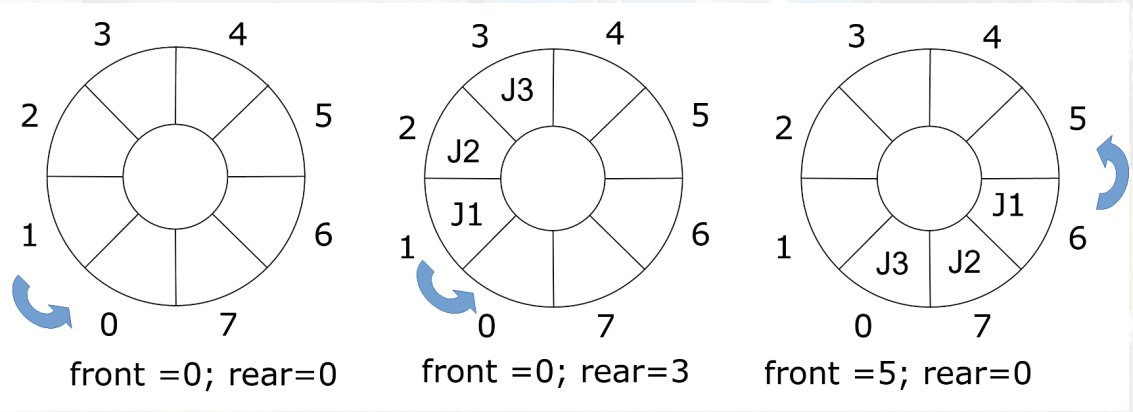
Solution: Circular Queue

- Initially, `front = rear = 0;`

Solution: Circular Queue

- Initially, `front = rear = 0;`
- `front`: one position counterclockwise from the first element in the queue.
- `rear`: current end of the queue.



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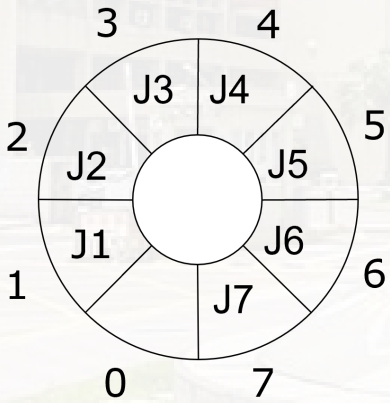
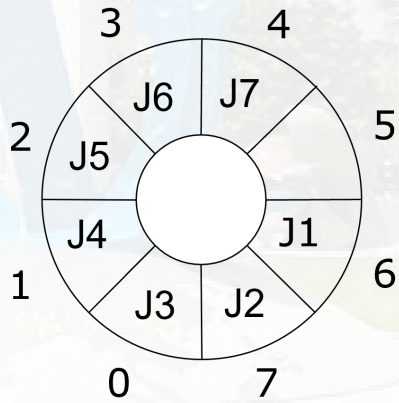
- Such a circular queue is permitted to hold at most MAX_QUEUE_SIZE $-$ 1 elements.
- The addition of an element such that `front == rear`: the queue is empty (?) or full (?).



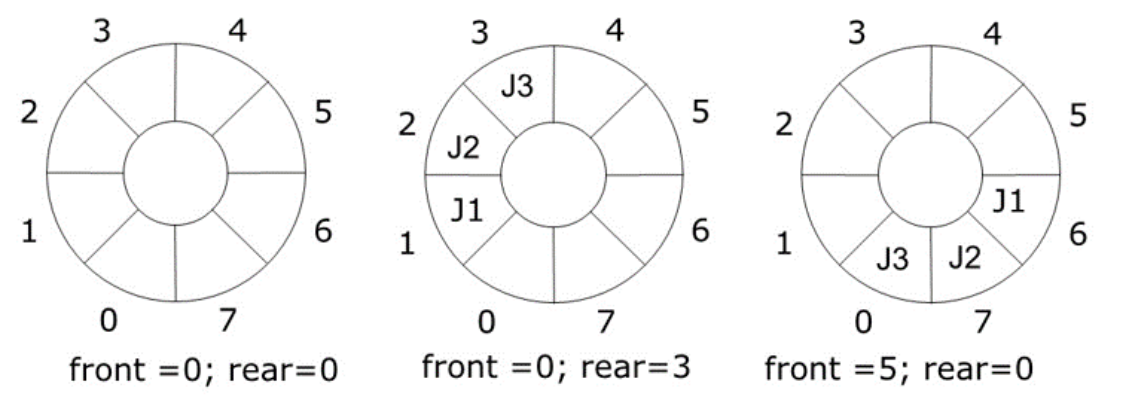
front =0; rear=7



front =5; rear=4

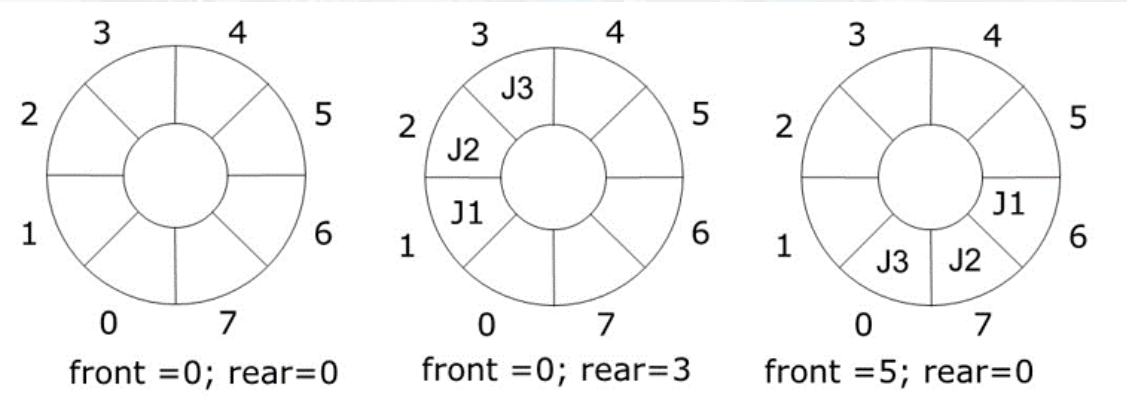
Adding an Element to a Circular Queue

```
void Enqueue(element item) {
    rear = (rear+1) % MAX_QUEUE_SIZE;
    if (front == rear) {
        queueFull(); // reset rear and print error!
    }
    queue[rear] = item;
}
```



Deleting an Element from a Circular Queue

```
element Dequeue() {
    element item;
    if (front == rear) {
        return queueEmpty();
    }
    front = (front+1) % MAX_QUEUE_SIZE;
    return queue[front];
}
```



Discussions