

Queues

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Outline

- 1 Definition
- 2 Implementation
- 3 Sequential Queue & Circular Queue

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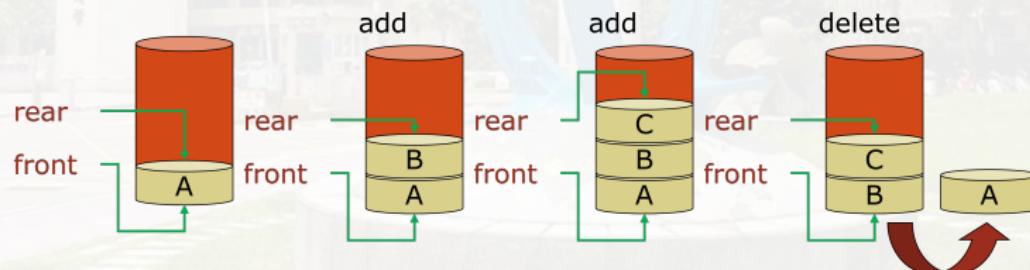
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Definition

- 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
int rear = -1; // initially no element
```

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If the queue is not full, `queue[++rear] = element;`
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- 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
0	2		J_2	J_3		Job J_1 is deleted
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- We should move the ENTIRE queue to the left. $\Rightarrow O(MAX_QUEUE_SIZE)$ (very time consuming!)

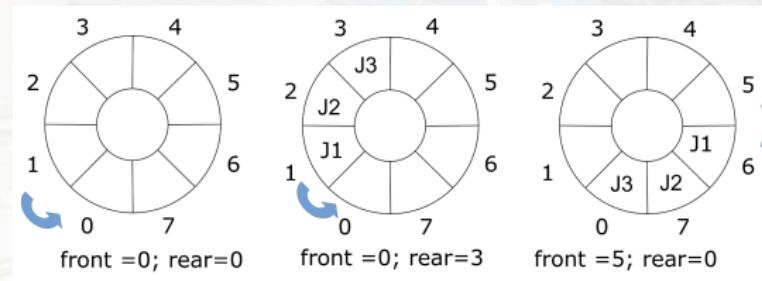


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- Initially, $\text{front} = \text{rear} = 0$;
- front : one position counterclockwise from the first element in the queue.
- rear : current end of the queue.



Circular Queue (2/2)

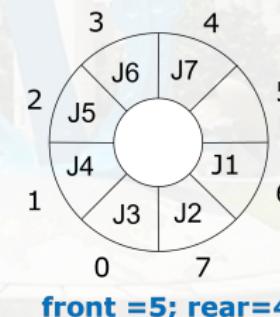
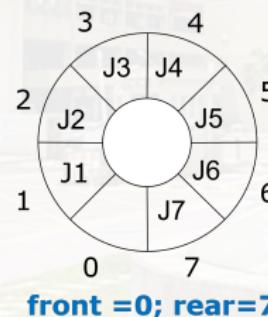
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Circular Queue (2/2)

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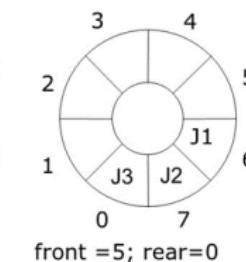
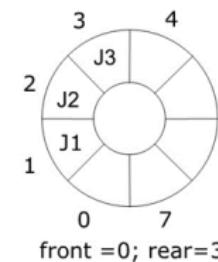
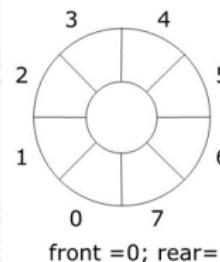
Circular Queue (2/2)

- 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 (?).



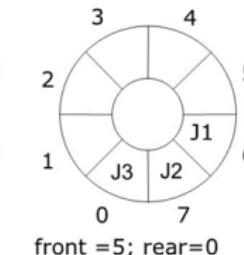
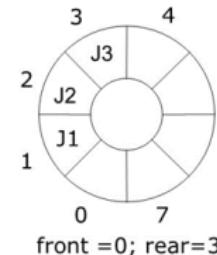
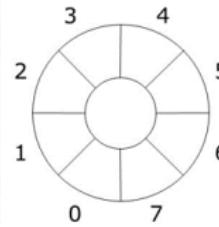
Adding an Element to a Circular Queue

```
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];  
}
```

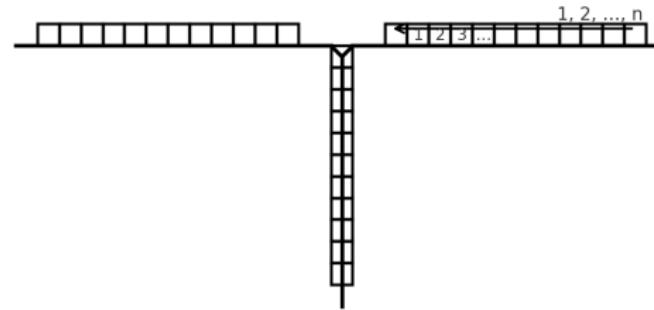


Brainstorming: Railroad Switching Network Using Queue

- Suppose the switch is implemented by a queue. For cars coming in order $1, 2, \dots, n$, what are the possible permutations of the cars that can be obtained? Are any permutations impossible?

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- Suppose the switch is implemented by a queue. For cars coming in order $1, 2, \dots, n$, what are the possible permutations of the cars that can be obtained? Are any permutations impossible?
 - Like $(3, 1, 2)$? $(3, 2, 1)$?



Discussions