CPE 212 - Fundamentals of Software Engineering

Queues

Outline

- Queue Definition
- Concepts
- Implementations
- Coding Examples

Queue ADT

An ordered homogeneous data structure in which elements are added to the rear and removed from the front

FIFO - First In, First Out

Example:

Check out line at the grocery store

Queue - Basic Operations

Enqueue - Adds one element to the rear of the queue

Dequeue - Removes and returns item from the front of the queue

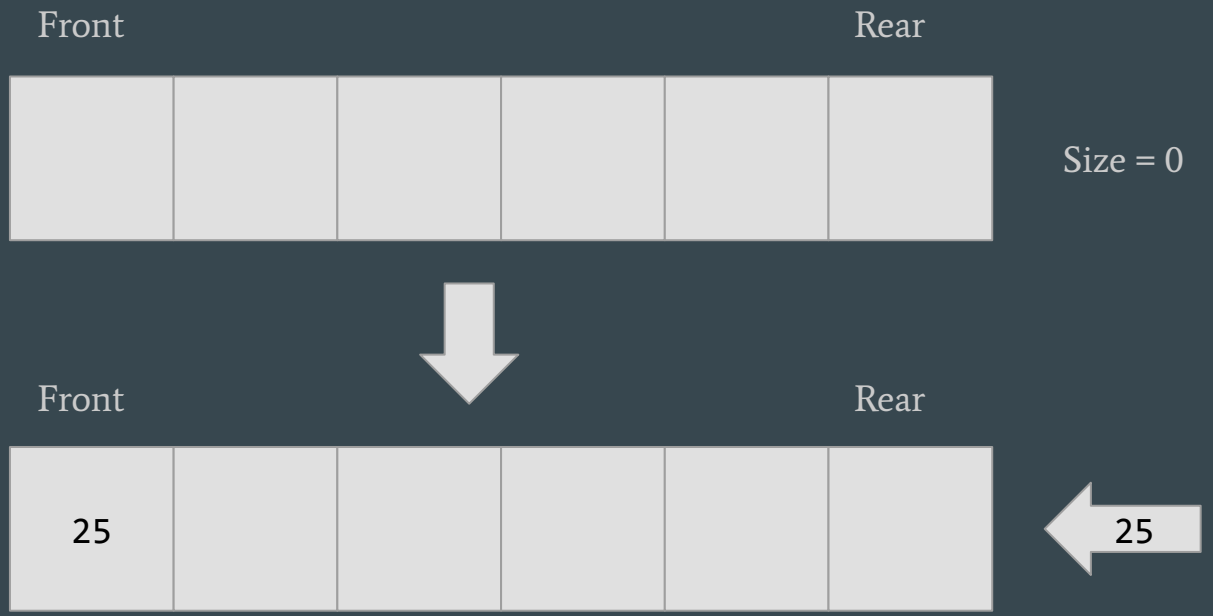
IsEmpty - Determines whether the queue is empty

IsFull - Determines whether the queue is full

MakeEmpty - Initializes the queue to the empty state

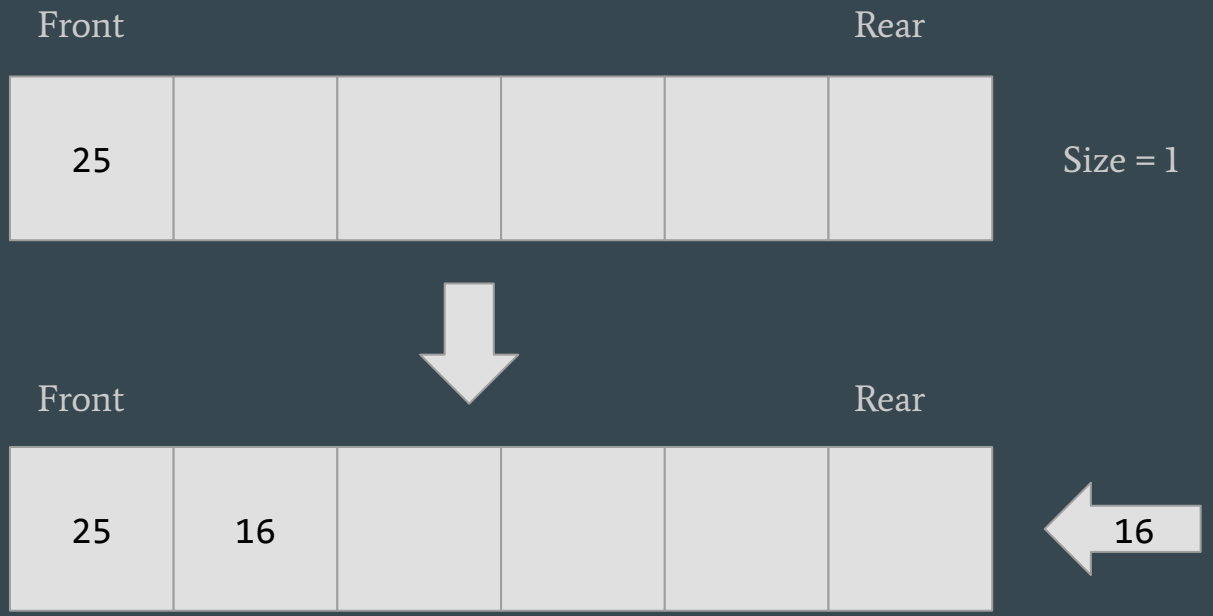
Enqueue

```
Enqueue(25);
```



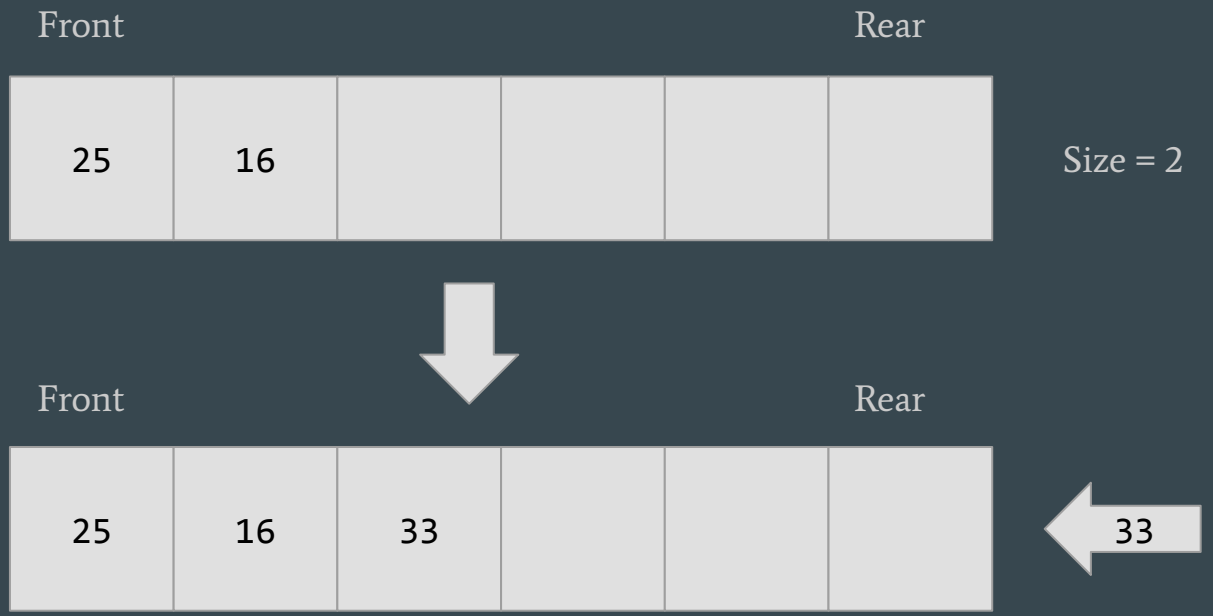
Enqueue

```
Enqueue(16);
```



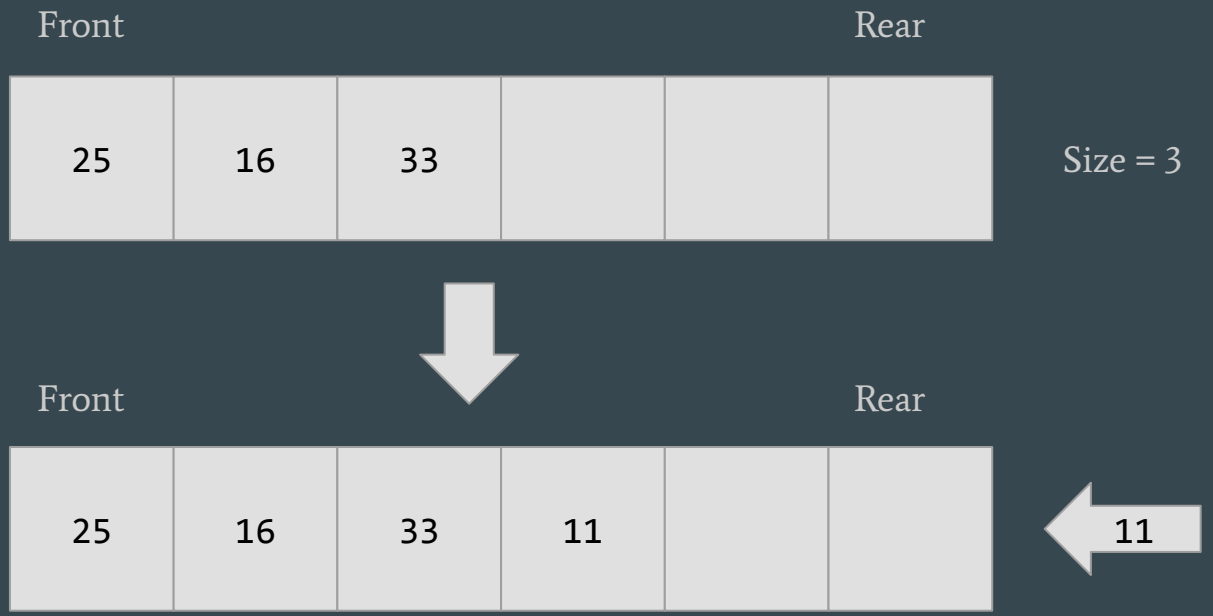
Enqueue

```
Enqueue(33);
```



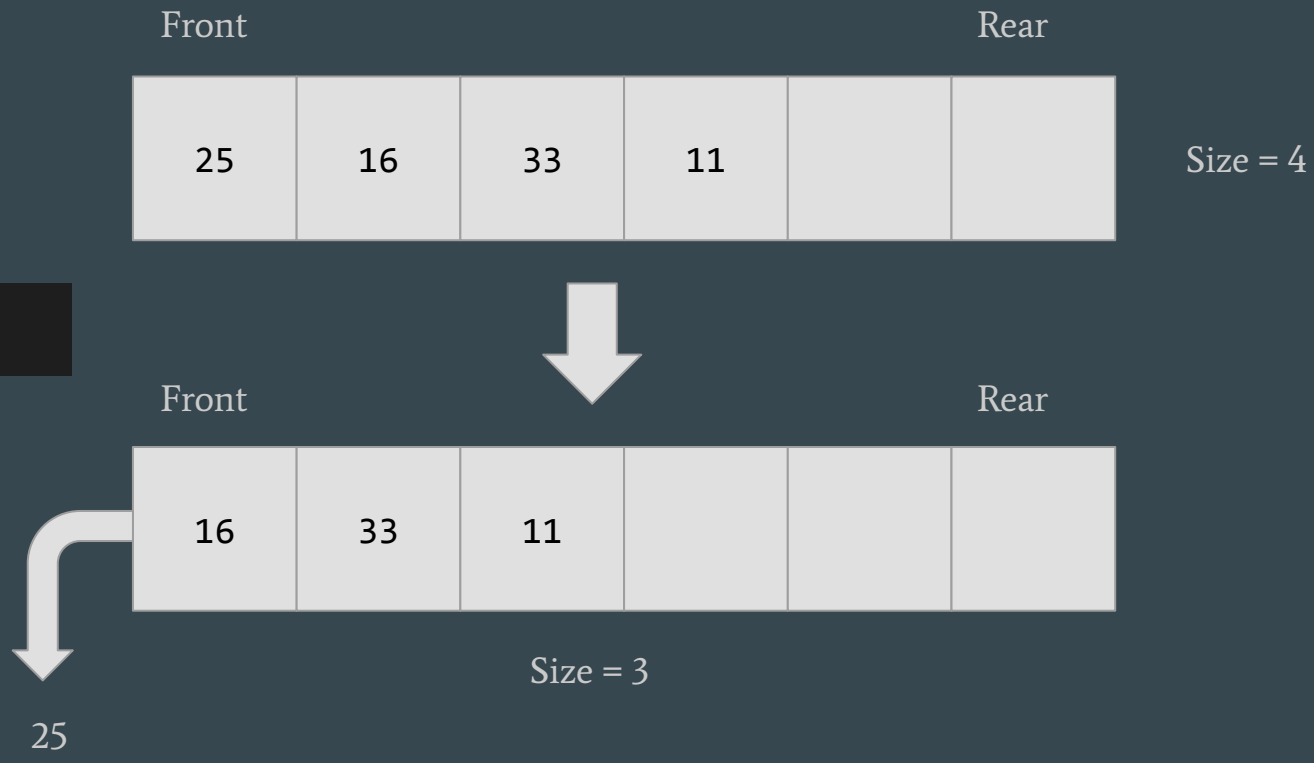
Enqueue

```
Enqueue(11);
```



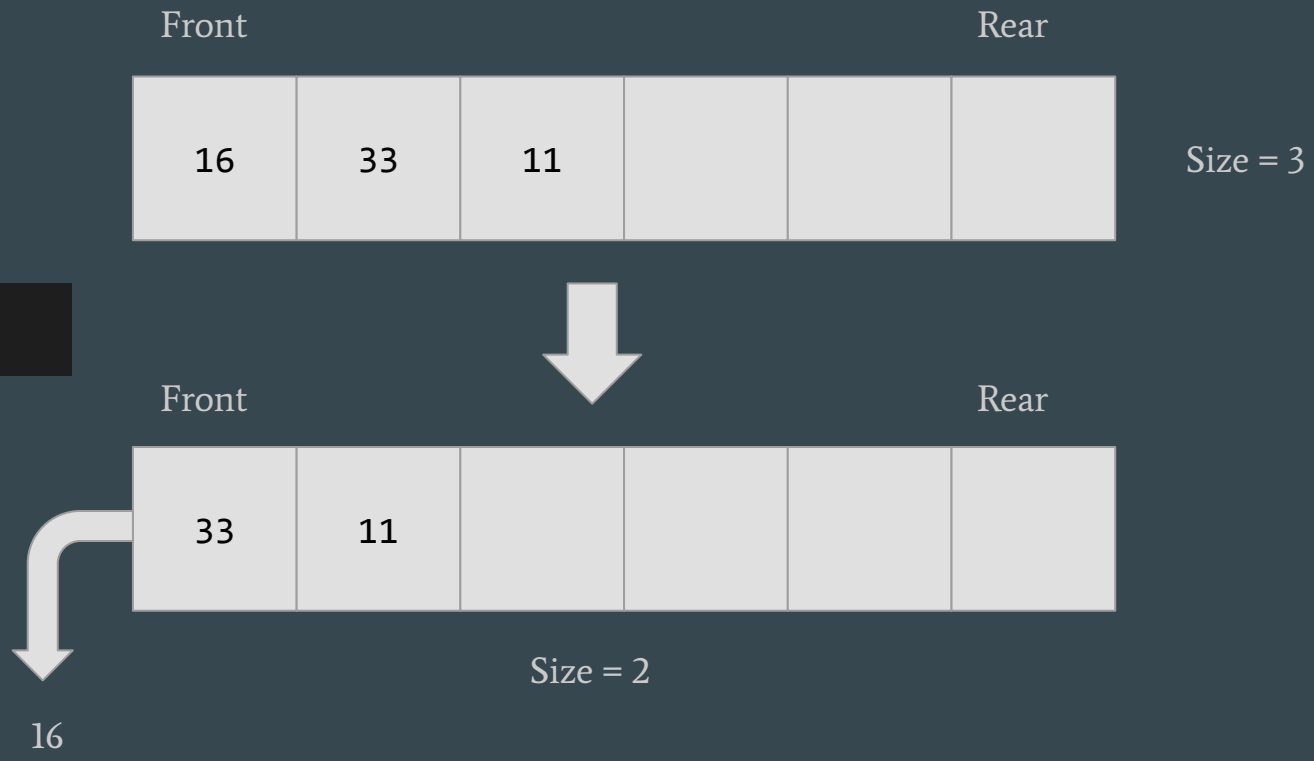
Dequeue

```
Dequeue();
```



Dequeue

```
Dequeue();
```



Queue - Operation Limitations

What happens when Enqueue is invoked when the queue is full?

What happens when Dequeue is invoked when the queue is empty?

Same options as with Stack ADT

- Option #1 – Client is responsible
- Option #2 – Container is responsible

How would you implement a queue?

Queue - Implementations

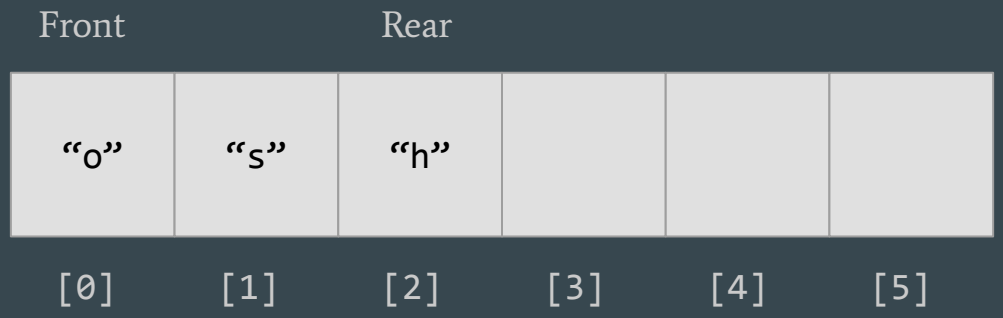
- Arrays
  - Fixed front
  - Floating front
  - Circular
- Linked Lists
  - Single links
  - Double links

Queue - Fixed Front: Enqueue

Queue - Fixed Front: Dequeue

What do we need to do next?

Queue - Fixed Front: Dequeue



The array has to be shifted down to accommodate the removed item

Fixed Front Queue Advantages/Disadvantages?

Queue - Fixed Front

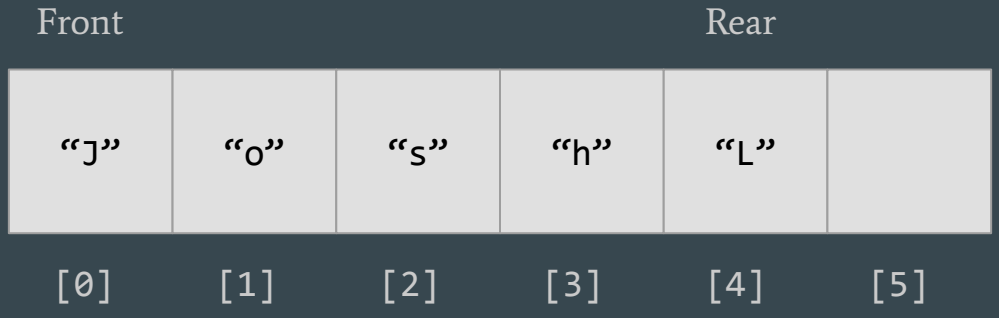
Advantages

- Simple to code
- Easy to determine status Full/Empty
- Easy to identify place to add new item

Disadvantages

- Sliding elements downward takes time
- Resizing

Queue - Floating Front: Enqueue



Queue - Floating Front: Dequeue

Floating Front Queue Advantages/Disadvantages?

Array - Floating Front: Problem

```
Enqueue("L");
```

Queue - Fixed Front

Advantages

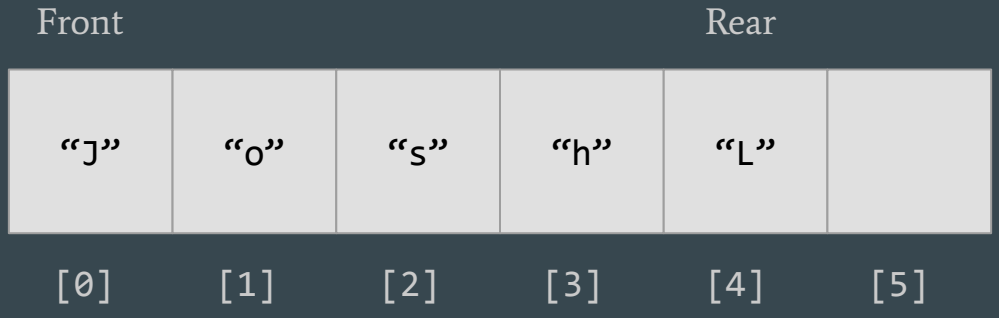
- Simple to code
- Easy to determine status Full/Empty

Disadvantages

- Running out of elements
- Resizing

Queue - Circular: Enqueue

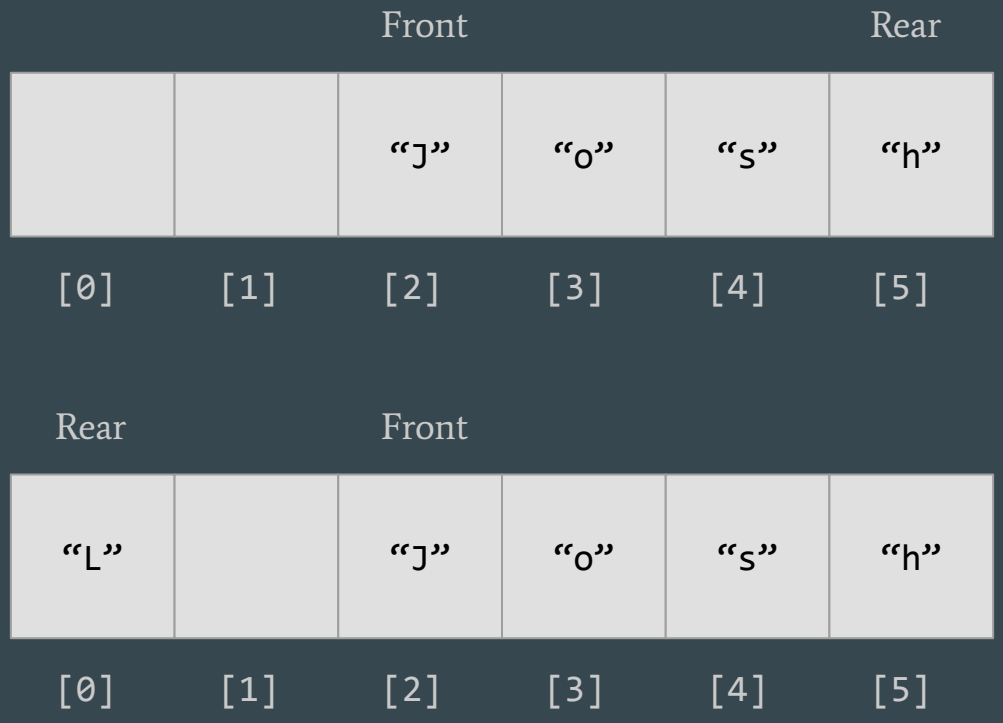
```
Enqueue("L");
```



Queue - Circular: Dequeue

Queue - Circular: Wrap

```
Enqueue(“L”);
```



Circular Queue Advantages/Disadvantages?

Queue - Circular

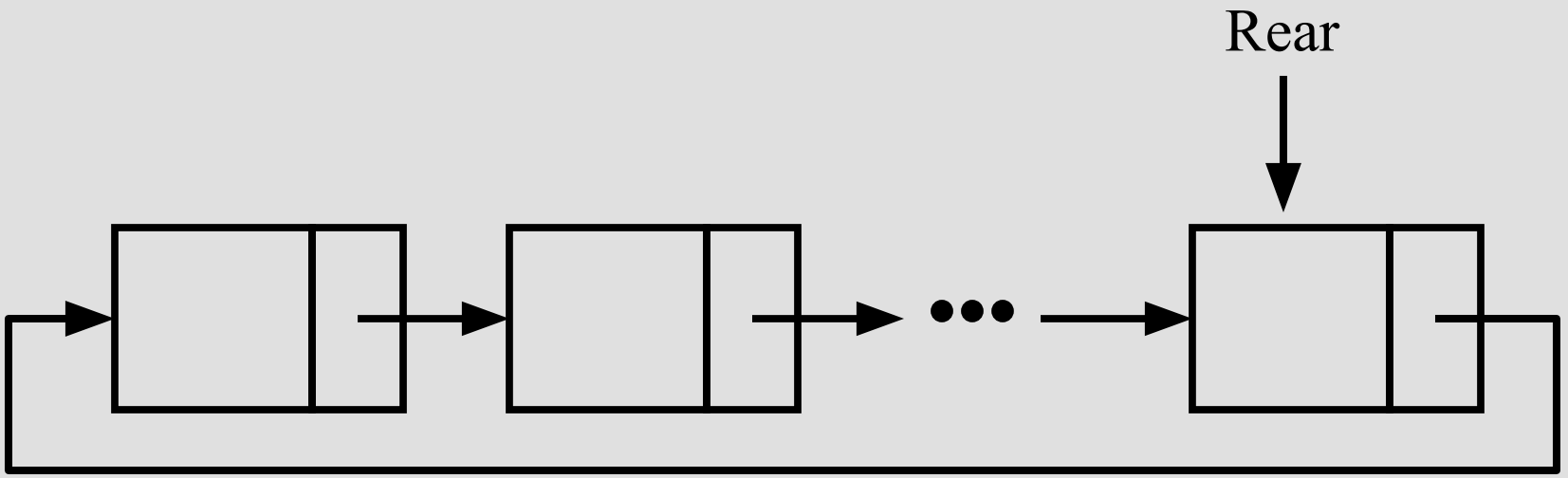
Advantages

- Can utilize the entire array
- Speed

Disadvantages

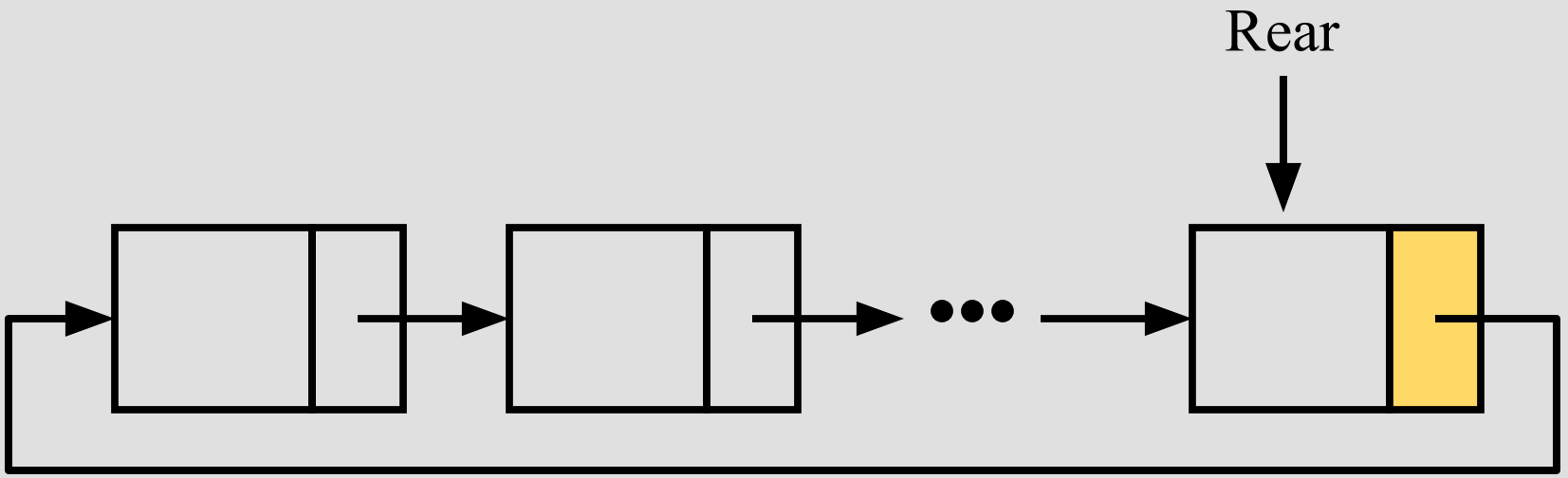
- More complex implementation
- Resizing

Queue - Circular Linked



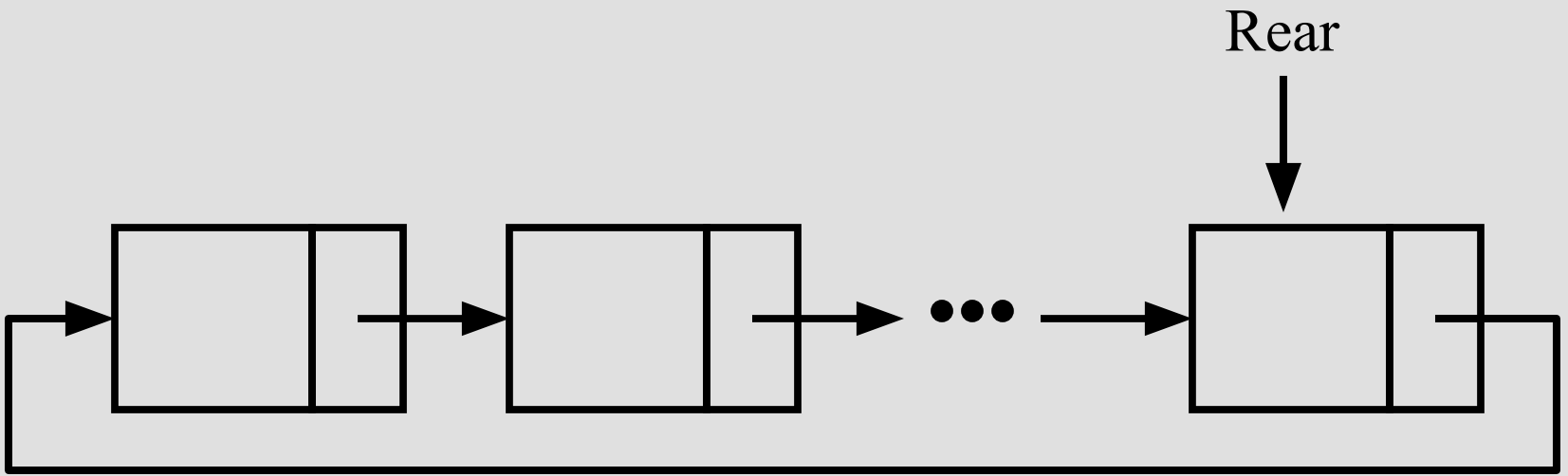
Where is the front of this queue?

Queue - Circular Linked



Rear->next points to the front

Queue - Circular Linked



How do you know if the queue is empty?

Queue - Circular Linked

Rear = NULL

Queue - Summary

- Queues are First-In, First-Out containers
- Several ways to implement a Queue
  - Arrays (static or dynamic)
    - With Fixed Front, Floating Front, or Circular
  - Linked, dynamically allocated nodes
  - Tradeoffs:
    - Array implementations are memory efficient but difficult to resize
    - Linked node implementation uses more memory per data element but allows size of container to vary based upon amount of data

Code Examples