

CSE 332 Summer 2024

Lecture 1: Intro to ADTs, Stacks, Queues

Nathan Brunelle

<http://www.cs.uw.edu/332>

Nathan Brunelle

- Born: Virginia Beach, VA
- Ugrad: Math and CS at University of Virginia
- Grad: CS at University of Virginia
- Taught at UVA for 6 years
 - Intro to programming (e.g. 121)
 - Discrete Math (e.g. 311)
 - Algorithms (e.g. 412)
 - Theory of Computation (e.g. 431)



Warm Up!

Put up one hand (you can switch if it gets tired)!

Set your counter to 1

While (you and at least one other person have a hand up){

 Make a partnership with someone whose hand is still raised

 Share your name with your partner

 Add together your counter and your partner's counter

 Identify which of you woke up earliest this morning

 Release partnership

 If you woke up earlier, then put your hand down and return to your seat

}

About this course

Topics covered:

- Data Structures
 - Specific “classic” data structures
- Introduction to Algorithms and Analysis
- Parallelism and Concurrency
 - Parallelism: Use multiple processors to finish sooner
 - Concurrency: Correct access to shared resources

Course Staff

- Instructor:
 - Nathan Brunelle
- TAs:
 - Katherine
 - Charles
 - Juliette
 - Khushi
 - Angie

Course Info

- Text (optional):
 - Data Structures & Algorithm Analysis in Java, (Mark Allen Weiss), 3rd edition, 2012
(2nd edition also o.k.)
- Course Page:
 - <http://www.cs.uw.edu/332>

Communication

- Ed STEM Discussion board
 - Your first stop for questions about course content & assignments

Course Meetings

- Lecture
 - Materials posted (slides before class, inked slides after)
 - Recorded using Panopto
 - Ask questions, focus on key ideas (rarely coding details)
- Section
 - Practice problems!
 - Answer Java/homework questions, etc.
 - Occasionally may introduce new material
 - An important part of the course (not optional)
- Office hours
 - Use them: *please visit us!*

Grading

- 13 Weekly-ish homework exercises (5% each, 65% total)
 - You may resubmit 2 (one from before midterm, one from after)
 - Resubmitted assignment's grade replaces the original
- Midterm and final exam (35%, weighted equally)
 - In-person
 - Midterm on Friday 7/19
 - Final on last day of class (8/16)

Collaboration

- Try it yourself first
- Collaborate with classmates (no external interactive help on assignments permitted)
 - Collaboration is “whiteboard only”
 - Looking for a collaborator?
 - Post on the Ed Discussion board
 - Go to the CSE study room (Allen Center 006, there’s a table specifically for 332!)
- Cite your sources!

Terminology

- Abstract Data Type (ADT)
 - Mathematical description of a “thing” with set of operations on that “thing”
- Algorithm
 - A high level, language-independent description of a step-by-step process
- Data structure
 - An organization of data and family of algorithms for implementing an ADT
- Implementation of a data structure
 - The data organization and algorithms written in a programming language

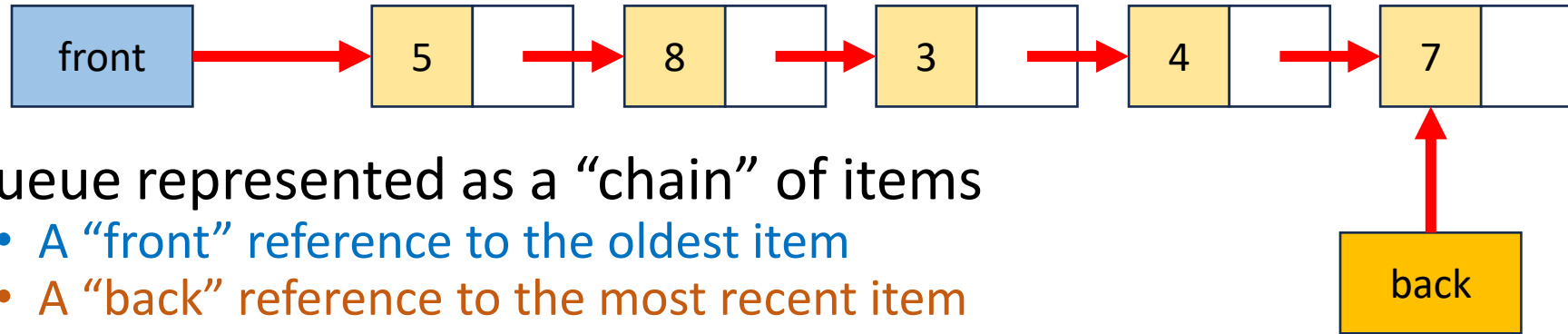
ADT: Queue

- What is it?
- What operations do we need?
- Suggested data structures?

ADT: Queue

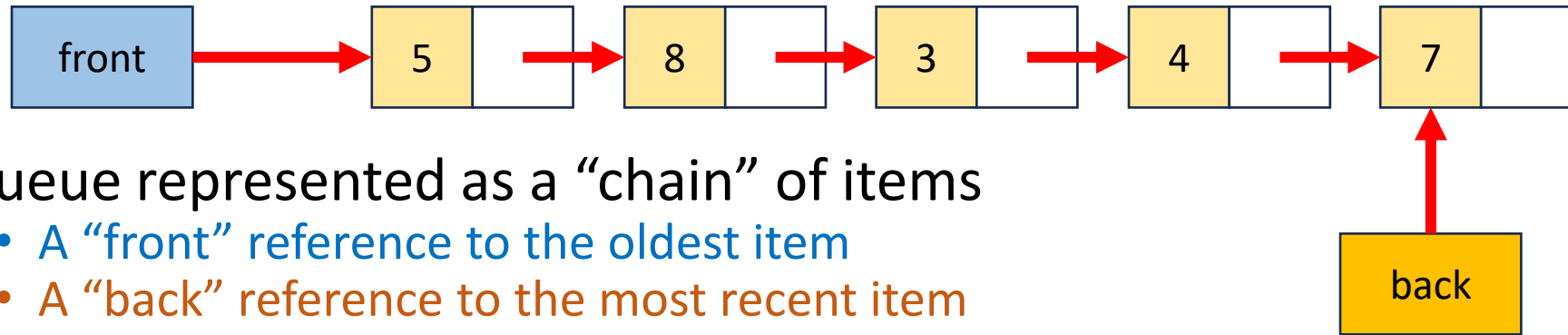
- What is it?
 - A collection of items that we interact with in a “First In First Out” (FIFO) way
- What operations do we need?
 - Enqueue
 - Add a new item to the queue
 - Dequeue
 - Remove the “oldest” item from the queue
 - IsEmpty
 - Indicate whether or not there are items still on the queue

Linked List – Queue Data Structure



- Queue represented as a “chain” of items
 - A “front” reference to the oldest item
 - A “back” reference to the most recent item
 - Each Node references the item enqueued after it
- enqueue Procedure:
- dequeue Procedure:
- isEmpty Procedure:

Linked List – Queue Data Structure



- Queue represented as a “chain” of items
 - A “front” reference to the oldest item
 - A “back” reference to the most recent item
 - Each Node references the item enqueued after it

• enqueue Procedure:

```
enqueue(x){  
    last = new ListNode(x);  
    back.next = last;  
    back = last;  
}
```

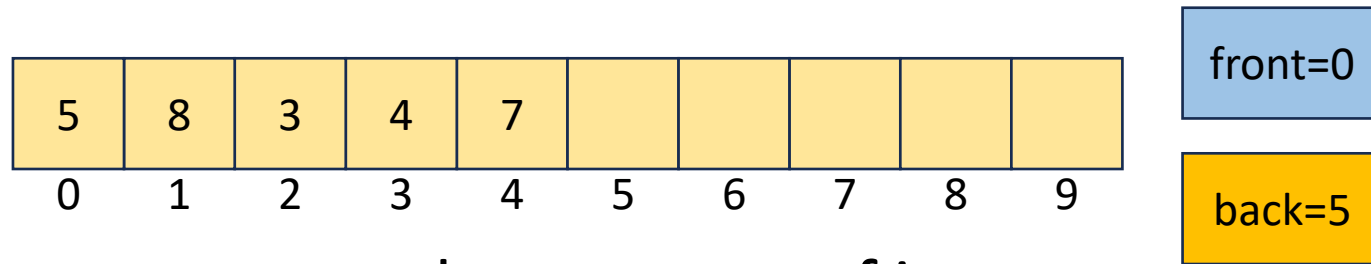
• dequeue Procedure:

```
dequeue(){  
    first = front.value;  
    front = front.next;  
    return first  
}
```

• isEmpty Procedure:

```
isEmpty(){  
    return front == null;  
}
```

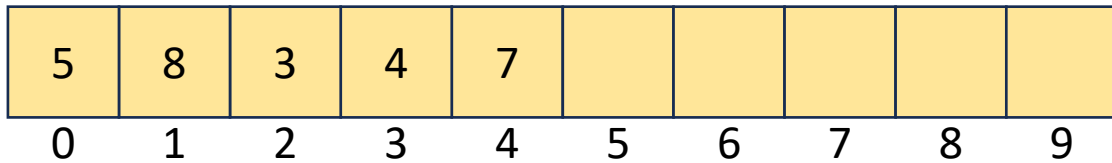
“Circular” Array – Queue Data Structure



- Queue represented as an array of items
 - A “front” index to indicate the oldest item in the queue
 - A “back” index to indicate the most recent item in the queue
 - Actually, the first “open” slot in the array
- enqueue Procedure:
- dequeue Procedure:
- isEmpty Procedure:

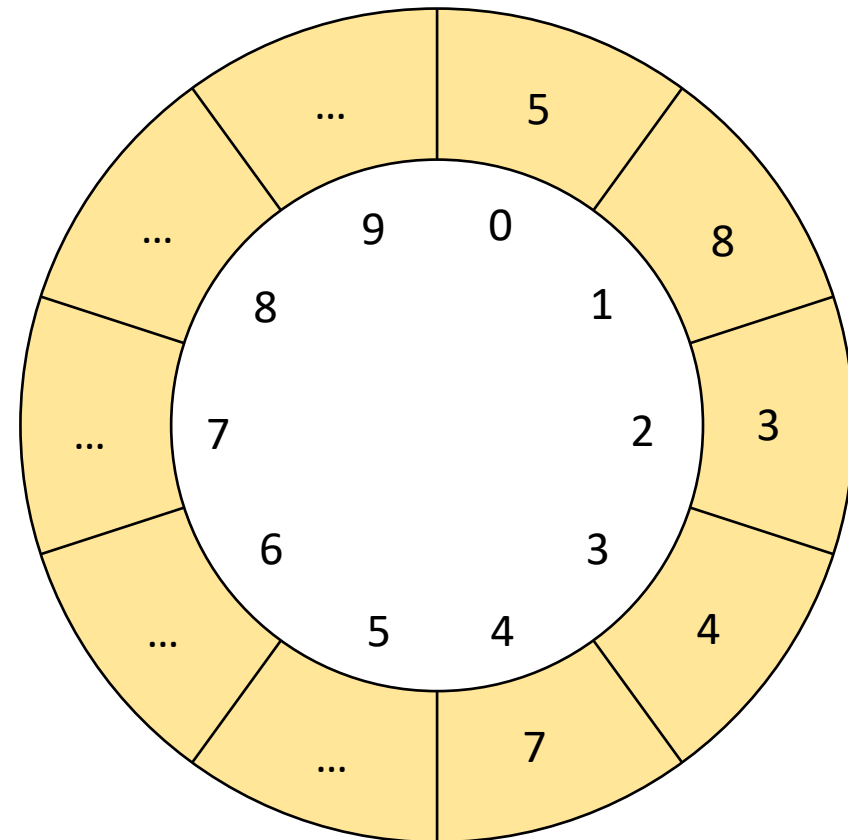
“Circular” Array

- Intuitively, An array of values arranged in a “circle” rather than a line
 - If you go beyond the last index, to wrap back around to 0

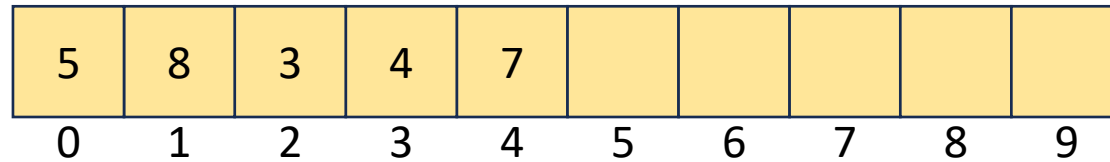


front=0

back=5



“Circular” Array – Queue Data Structure



front=0

back=5

- Queue represented as an array of items
 - A “front” index to indicate the oldest item in the queue
 - A “back” index to indicate the most recent item in the queue

- enqueue Procedure:

```
enqueue(x){  
    queue[back] = x;  
    back = (back + 1) % queue.length;  
    size++;  
}
```

- dequeue Procedure:

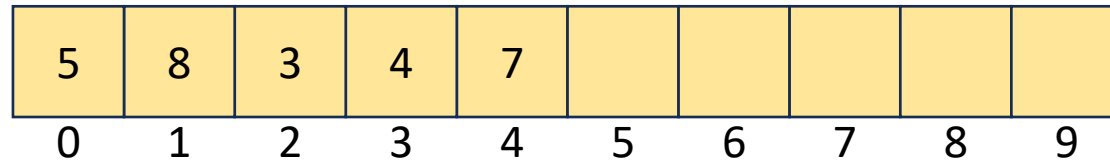
```
dequeue(){  
    first = queue[front];  
    front = (front + 1) % queue.length;  
    size--;  
    return first;  
}
```

- isEmpty Procedure:

```
isEmpty(){  
    return size == 0;  
}
```

What if we run out of space?!

“Circular” Array – Queue Data Structure



front=0

back=5

- Queue represented as an array of items
 - A “front” index to indicate the oldest item in the queue
 - A “back” index to indicate the most recent item in the queue

- enqueue Procedure:

```
enqueue(x){  
    if (size == queue.length) {resize();}  
    queue[back] = x;  
    back = (back + 1) % queue.length;  
    size++;  
}
```
- dequeue Procedure:

```
dequeue(){  
    first = queue[front];  
    front = (front + 1) % queue.length;  
    size--;  
    return first;  
}
```
- isEmpty Procedure:

```
isEmpty(){  
    return size == 0;  
}
```

Linked List vs. Circular Array

ADT: Stack

- What is it?
- What operations do we need?
- Suggested data structures?

ADT: Stack

- What is it?
 - A “Last In First Out” (LIFO) collection of items (sometimes called FILO)
- What operations do we need?
 - push
 - Add a new item onto the stack
 - peek
 - Return the value of the most recently pushed item
 - pop
 - Return the value of the most recently pushed item and remove it from the stack
 - isEmpty
 - Indicate whether or not there are items still on the stack