

# CSE 143

## Computer Programming II

## Linked Lists II



### What Are We Doing Again?

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#### What Are We Doing...?

We're building an alternative data structure to an `ArrayList` with different efficiencies.

#### Today's Main Goals:

- Get more familiarity with `LinkedLists`
- Write more `LinkedList` methods
- Learn how to "protect" against `NullPointerExceptions`

### A New `LinkedList` Constructor

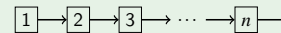
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#### New Constructor

Create a constructor

```
public LinkedList(int n)
```

which creates the following `LinkedList`, when given  $n$ :



What kind of loop should we use?

A `for` loop, because we have numbers we want to put in the list.

What cases should we worry about?

We're creating the list; so, there aren't really "cases".

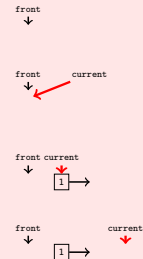
### A New `LinkedList` Constructor

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#### First Attempt

```
1 public LinkedList(int n) {
2
3     ListNode current = this.front;
4
5     for (int i = 1; i <= n; i++) {
6         current = new ListNode(i);
7
8         current = current.next;
9
10    }
11 }
12 }
```

/\* Current State \*/



Remember, to edit a `LinkedList`, we **MUST** edit one of the following:

- `front`, or
- `node.next` (for some `ListNode` node)

In our code above, we edit `current`, which is neither.

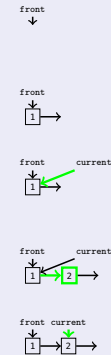
### A New `LinkedList` Constructor

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#### Second Attempt

```
1 public LinkedList(int n) {
2
3     if (n > 0) {
4         //n is at least 1...
5         this.front = new ListNode(1);
6
7         ListNode current = this.front;
8
9         for (int i = 1; i <= n; i++) {
10            current.next = new ListNode(i);
11
12            current = current.next;
13
14        }
15    }
16 }
```

/\* Current State \*/



## A New LinkedList Constructor: Another Solution

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This other solution works by going backwards. Before, we were editing the next fields. Here, we edit the front field instead:

### Different Solution!

```

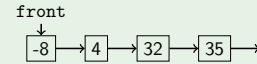
1 public LinkedList(int n) {
2
3     for (int i = n; i > 0; i--) {
4         ListNode next = this.front;
5
6         this.front = new ListNode(i, next);
7
8     } /* Second time through the loop (for demo)... */
9     //ListNode next = this.front;
10
11     //this.front = new ListNode(i, next);
12
13 }
    
```

## Implementing addSorted

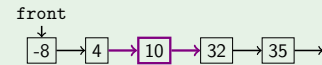
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### addSorted

Write a method `addSorted(int value)` that adds `value` to a sorted `LinkedList` and **keeps it sorted**. For example, if we call `addSorted(10)` on the following `LinkedList`,



We would get:



As always, we should approach this by considering the separate cases (and then drawing pictures):

- We're supposed to insert at the front
- We're supposed to insert in the middle
- We're supposed to insert at the back

## Case: Middle

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### An Incorrect Solution

```

1 public void addSorted(int value) { //Say value = 10...
2
3     ListNode current = this.front;
4
5     while (current.data < value) {
6         current = current.next;
7
8     }
9
10    ...the while loop continues...
11
12    ...the while loop continues...
13
14 }
    
```

Uh Oh! We went too far! We needed the next field BEFORE us.

## Case: Middle

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### Fixing the Problem

```

1 public void addSorted(int value) { //Say value = 10...
2
3     ListNode current = this.front;
4
5     while (current.next.data < value) {
6         current = current.next;
7
8     }
9
10    ...the while loop STOPS now...
11
12    ListNode next = current.next;
13
14    current.next = new ListNode(value, next);
15 }
    
```

Does this cover all the cases?

## Case: End

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### Adding At The End?

```

1 public void addSorted(int value) { //Say value = 40...
2
3     ListNode current = this.front;
4
5     while (current.next.data < value) {
6         current = current.next;
7
8     }
9
10    ...the while loop continues...
11
12    ... AND IT KEEPS ON GOING...
13
14    current.next.data -> NullPointerException!!!
15 }
    
```

We fell off the end of the LinkedList.  
Idea: Make sure `current.next` exists.

## Case: End

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### Adding At The End?

```

public void addSorted(int value) {
    ListNode current = this.front;
    /* If we are making a check for current.next, we must
     * be sure that current is not null. */
    while (current.next.data < value) {
        /* Since we want to keep on going here,
         * the check must be made in the while loop.
         */
        current = current.next;
    }
}
    
```

### A Fix?

```

public void addSorted(int value) {
    ListNode current = this.front;
    /* The extra check here is useless...we've already checked
     * current.next by the time we get to it. */
    while (current.next.data < value && current.next != null) {
        current = current.next;
    }
}
    
```

### A Real Fix!

```

public void addSorted(int value) {
    ListNode current = this.front;
    while (current.next != null && current.next.data < value) {
        current = current.next;
    }
}
    
```

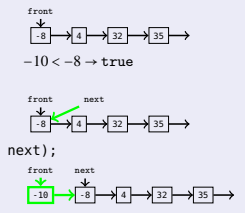
## Case: Beginning

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Our current code only sets `current` to a new `ListNode`. Importantly, this never updates `front`; so, we lose the new node.

### Adding At The Beginning?

```
1 public void addSorted(int value) { //Say value = -10...
2
3     if (value < front.data) {
4         ListNode next = front;
5
6         front = new ListNode(value, next);
7
8     }
9     else {
10        ...
11    }
12 }
```



Have we covered all of our cases now?

## Protecting Our Tests!

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With `LinkedList` code, every time we make a test (`if`, `while`, etc.), we need to make sure we're protected. Our current code is:

### Working Code?

```
1 public void addSorted(int value) {
2     if (value < front.data) {
3         ListNode next = front;
4         front = new ListNode(value, next);
5     }
6     else {
7         while (current.next != null && current.next.data < value) {
8             current = current.next;
9         }
10        ListNode next = current.next;
11        current.next = new ListNode(value, next);
12    }
13 }
14 }
```

We're "protected" if we **know** we won't get a `NullPointerException` when trying the test. So, consider our tests:

- `value < front.data`
- `current.next != null && current.next.data < value`

So, Are We Protected?

## Protecting Our Tests!

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Nope! What happens if `front == null`? We try to get the value of `front.data`, and get a `NullPointerException`. The fix:

### Working Code!

```
1 public void addSorted(int value) {
2     if (front == null || value < front.data) {
3         ListNode next = front;
4         front = new ListNode(value, next);
5     }
6     else {
7         while (current.next != null && current.next.data < value) {
8             current = current.next;
9         }
10        ListNode next = current.next;
11        current.next = new ListNode(value, next);
12    }
13 }
14 }
```

Helpfully, this fix actually handles the empty list case correctly!

## Some LinkedList Tips!



- Make sure to try all the cases:
  - Empty List
  - Front of Non-empty List
  - Middle of Non-empty List
  - Back of Non-empty List
- To Edit a `LinkedList`, the **assignment** must look like:
  - `this.front = <something>;`, or
  - `node.next = <something>;` (for some `ListNode` node in the list)
- Protect All Of Your Conditionals! Make sure that nothing can accidentally be null.
- When protecting your conditionals, make sure the less complicated check goes first.