Building Java Programs

Complex Linked List Code

reading: 16.2 – 16.3
Write a constructor for `LinkedIntList` that accepts an `int n` parameter and makes a list of the number from 0 to `n`:
- `new LinkedIntList(3)`: 

[Diagram of linked list with nodes labeled 3, 2, 1, 0]
addSorted

• Write a method `addSorted` that accepts an `int` as a parameter and adds it to a sorted list in sorted order.

  • Before `addSorted(17)`:

    Before `addSorted(17)`:

    front =

    `-4`

    data next
data next

    element 0 element 1

    element 2

  • After `addSorted(17)`:

    After `addSorted(17)`:

    front =

    `-4`

    data next
data next

    element 0 element 1 element 2

    `17`

    data next
data next

    element 2

    `22`

    data next
data next

    element 3
The common case

- Adding to the middle of a list: addSorted(17)

Which references must be changed?
What sort of loop do we need?
When should the loop stop?
First attempt

- An incorrect loop:

```java
ListNode current = front;
while (current.data < value) {
    current = current.next;
}
```

- What is wrong with this code?
  - The loop stops too late to affect the list in the right way.
changing a list

- There are only two ways to change a linked list:
  - Change the value of `front` (modify the front of the list)
  - Change the value of `<node>.next` (modify middle or end of list to point somewhere else)

- Implications:
  - To add in the middle, need a reference to the `previous` node
  - Front is often a special case
Key idea: peeking ahead

• Corrected version of the loop:

```java
ListNode current = front;
while (current.next.data < value) {
    current = current.next;
}
```

• This time the loop stops in the right place.
Another case to handle

- Adding to the end of a list:
  
  `addSorted(42)`

```plaintext
front = element 0

<table>
<thead>
<tr>
<th>data</th>
<th>next</th>
</tr>
</thead>
<tbody>
<tr>
<td>-4</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td></td>
</tr>
</tbody>
</table>
```

Exception in thread "main": `java.lang.NullPointerException`

- Why does our code crash?
- What can we change to fix this case?
## Multiple loop tests

- **A correction to our loop:**
  
  ```java
  ListNode current = front;
  while (current.next != null &&
          current.next.data < value) {
    current = current.next;
  }
  ```

  - We must check for a `next` of `null` **before** we check its `.data`.
Third case to handle

- Adding to the front of a list:
  \texttt{addSorted(-10)}

- What will our code do in this case?
- What can we change to fix it?
Handling the front

- Another correction to our code:

```java
if (value <= front.data) {
    // insert at front of list
    front = new ListNode(value, front);
} else {
    // insert in middle of list
    ListNode current = front;
    while (current.next != null &&
           current.next.data < value) {
        current = current.next;
    }
}
```

- Does our code now handle every possible case?
Fourth case to handle

- Adding to (the front of) an empty list:
  `addSorted(42)`

front =

- What will our code do in this case?
- What can we change to fix it?
Final version of code

// Adds given value to list in sorted order.
// Precondition: Existing elements are sorted
public void addSorted(int value) {
    if (front == null || value <= front.data) {
        // insert at front of list
        front = new ListNode(value, front);
    } else {
        // insert in middle of list
        ListNode current = front;
        while (current.next != null &&
            current.next.data < value) {
            current = current.next;
        }
    }
}
Common cases

- **middle**: "typical" case in the middle of an existing list
- **back**: special case at the back of an existing list
- **front**: special case at the front of an existing list
- **empty**: special case of an empty list