Singly Linked Lists

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March 2, 2022

Admin

- Lab 3 in!
- Lab 4 out this afternoon
- Partners again! Fill out opt-out form *by this afternoon*
- New kind of lab: refactoring existing code
- Masks still required
- Remember to come on time Friday for the quiz
    - Look at graded responses; solutions on website under “Handouts”

Linked Lists

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- But, the theater is very full. There are enough seats but we can’t all sit together
- How can I keep track of where all of you are sitting?
- One solution: keep a list of all of your seats
- Another option: I’ll keep track of one student. They keep track of the seat of the next student. So on and so forth
- Each student remembers the location of the next student (or none if they are the last). But I can still traverse all students!

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    - So: will implement all the operations that a `Vector` implements
    - (Looking ahead: will be faster for some operations; slower for others.)
- Uses the principle from the theater example: each piece of data remembers the location of the next

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  - Probably of generic type
- Also needs to store the location of the next piece of data
  - That is to say: needs to hold the next `Node`

Node

```
public class Node<E> {
   protected E data
   protected Node<E> nextElement;
    public Node(E v, Node<E> next) {
        data = v;
        nextElement = next;
    }
    public void setNext(Node<E> next) {
        nextElement = next;
    }
    public void setValue(E value) {
        data = value;
    }
```

```
    public Node<E> next() {
        return nextElement;
    }
    public E value() {
        return data;
    }
}
```

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    - Maybe some other useful `List` information? Perhaps the number of stored items
- And, then, need to implement methods

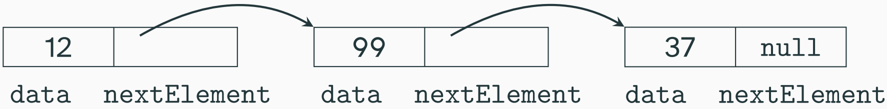
SinglyLinkedList

```
public class SinglyLinkedList<E>
{
    protected int count;                    // list size
    public Node<E> head; // ref. to first element

    public SinglyLinkedList()
    {
        head = null;
        count = 0;
    }

   //to fill in: methods...
```

Where we are now



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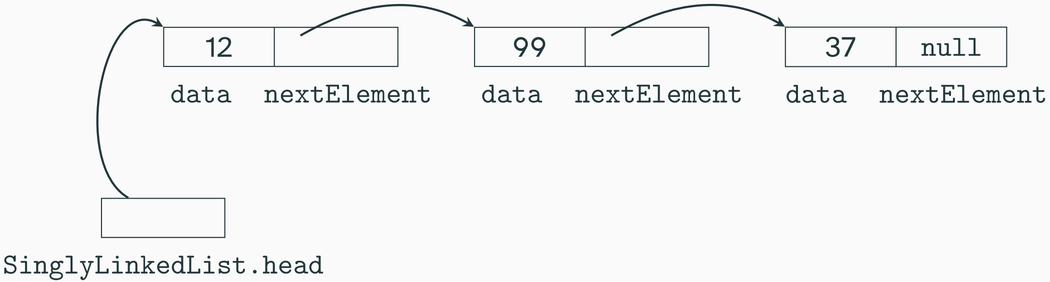

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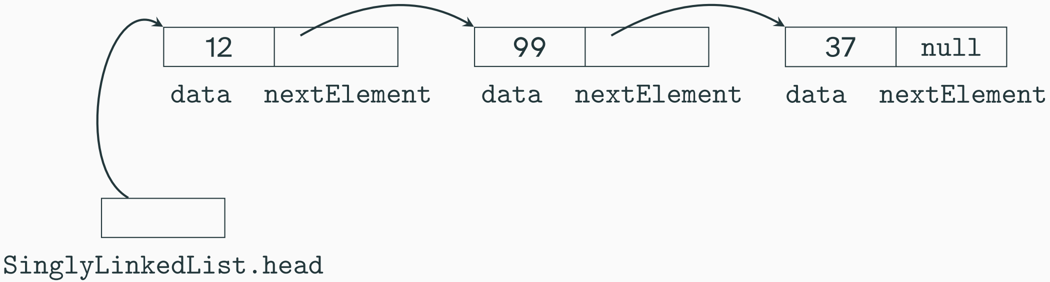

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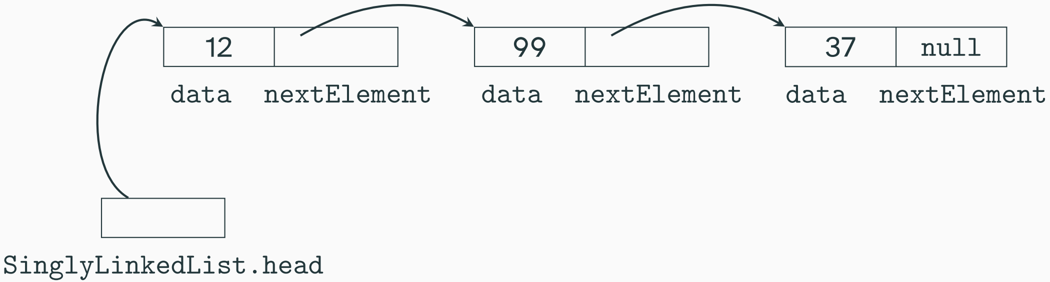

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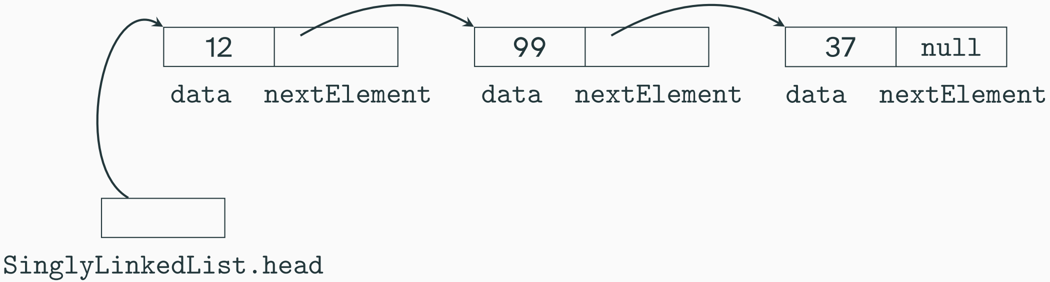

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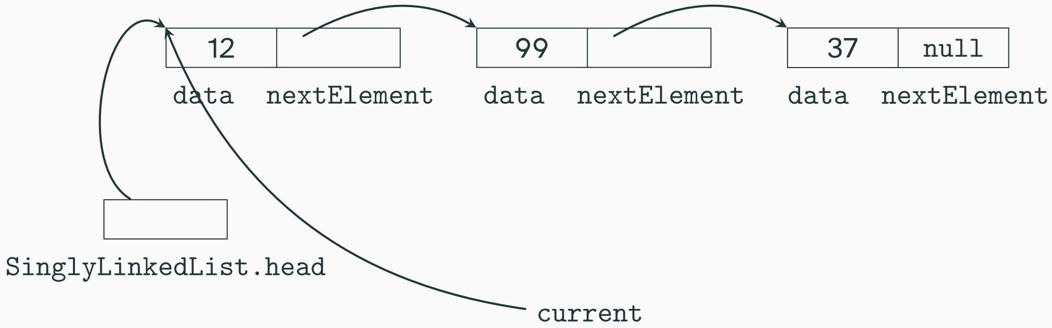
- How can we perform `contains()`?

Draft of `contains`

```java
public boolean contains(E value) {
   Node<E> current = head;
   while(current != null) { //why == if these are objects?
      if(value.equals(current.value())) {
         return true;
      }
   }
   return false;
}
```

Contains Diagram



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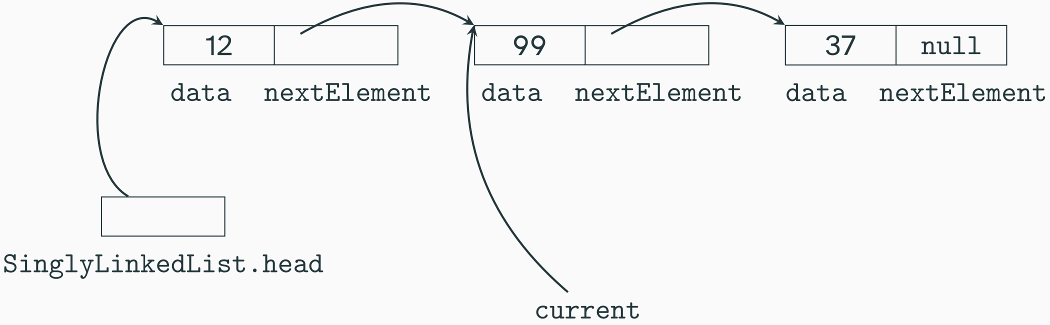

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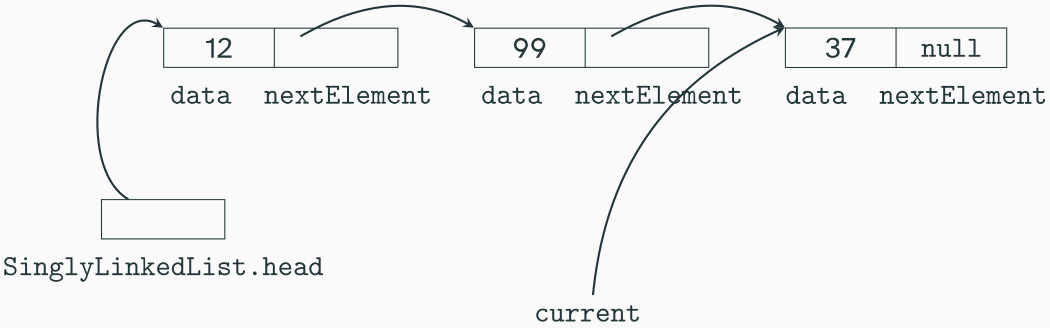

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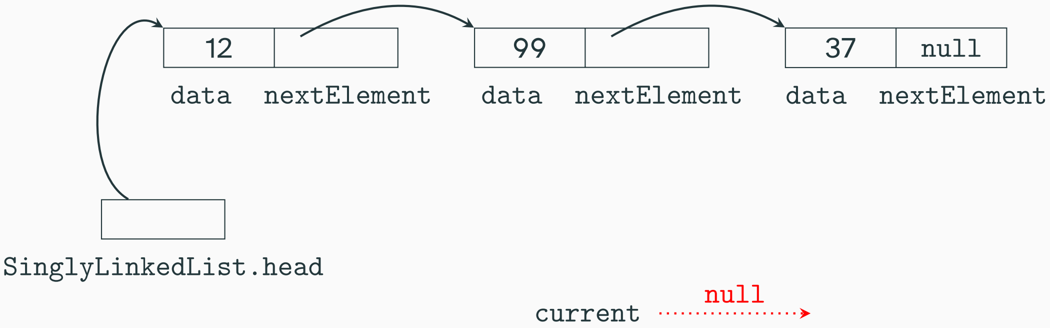

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    - Set the `nextElement` of `newNode` to be the previous `head`
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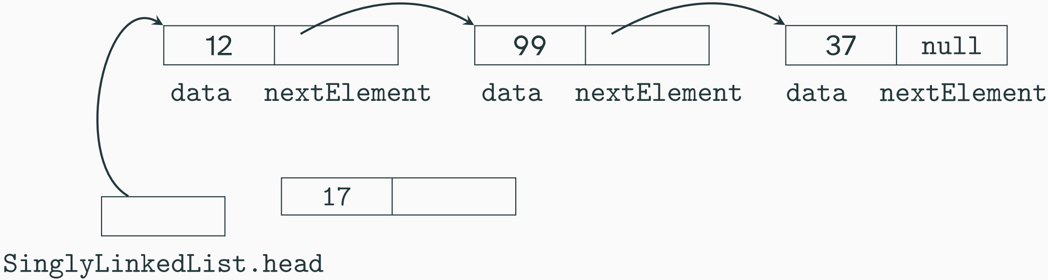
- Also: update `count`

Add Diagram (Adding 17)



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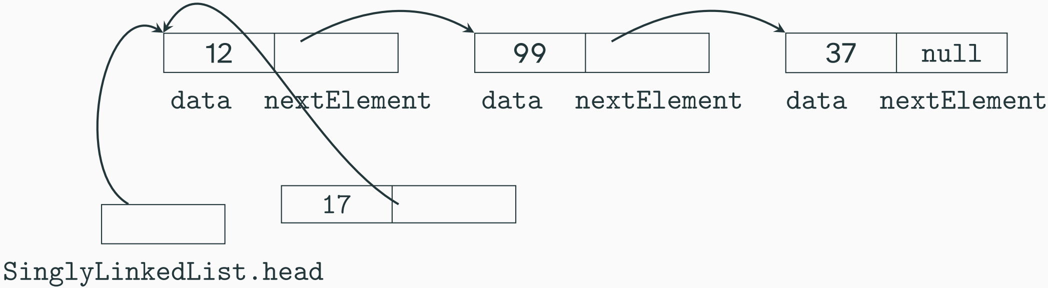

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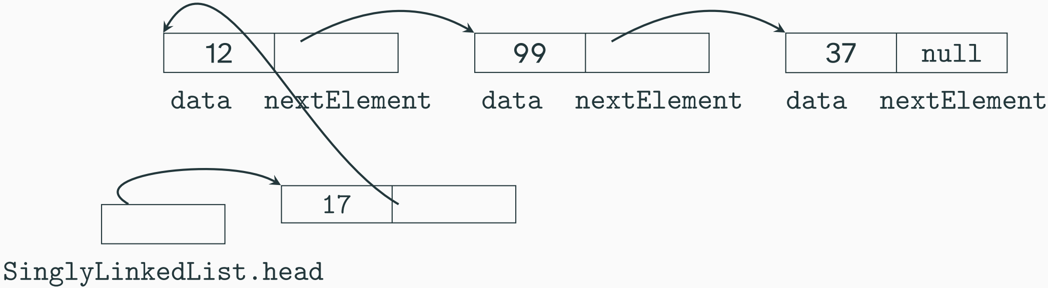

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- How can we implement `set(int, E)` and `get(int)`?
- How long do `set(int, E)` and `get(int)` take?
- If I have a `Node<E>` in the middle of my list, how long does it take to add a new node *after* it?

Motivating Recursion (Induction Intro)

Goal of this section

- Chat about what makes a recursive algorithm correct

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- We’ll get more formal about this on Friday

Finding number of X in a string

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public static int numX(String s) {
   if(s.length() == 0) {
      return 0;
   }
   if(s.charAt(s.lengt()-1) == 'X') {
      return 1 + numX(s.substring(0,s.length() - 1));
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How do we know that this method works correctly?

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- If `s` has length 0, then this algorithm correctly returns 0.

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- What if `s` has length 1?

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    - We know that `numX(s.substring(0,0))` returns `0` because we know that `numX` is correct on strings of length `0`.

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- So `numX()` works on strings of length at most 1.

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  - We know that `numX(s.substring(0,1)` is correct because we know that `numX` is correct on strings of length 1.
  - We add 1 if the first character is `'X'`, `0` otherwise. So we are correct for strings of length at most 2
- So `numX()` works on strings of length at most 2.

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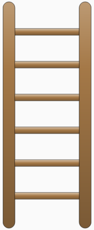
- Slowly argue that it works for larger and larger strings

Visualizing our Strategy



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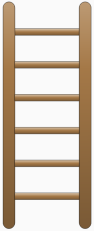

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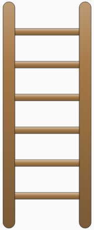

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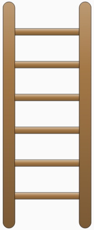

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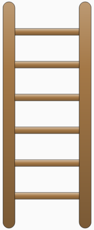

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    - Figure out how to get on some rung of the ladder
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- If I do both of these, will I always make it to the top of the ladder?

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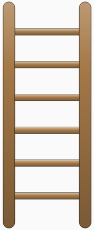

Ladder analogy: each step of the ladder is the length of the string in our recursive method. We want to show that our method is correct for a string of a certain length.

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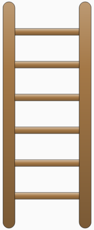

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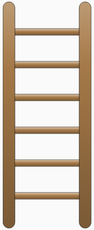

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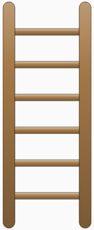

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