Implementing an Iterator

Loose Ends

- In implementing several kernel interfaces so far, you have been given code in the skeletons for the `iterator` method
- The code for this method is stylized and *sometimes* easy to adapt to a new situation, even if the code itself is hardly transparent!
  - Several new Java issues arise ...

Iterators

- Recall: iterators offer a special way of getting ***sequential access*** to all elements/ entries of a collection
- Because linked data structures are particularly appropriate for sequential access, the `List2` code is a good place to examine how iterators can be implemented

`iterator` Contract for `List`

`Iterator<T> iterator()`

- Returns an iterator over the elements.
- Ensures:

```
~this.seen * ~this.unseen =
    this.left * this.right
```

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- Returns an iterator over the elements.
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`Iterator` is an interface in the Java libraries (in the package `java.util`).

iterato

Iterator<T>

- Returns an it
- Ensures:

~this.seen `*` ***~this.unseen*** `=`

this.`left *` ***this.***`right`

These two variables stand for the ***string of*** `T` already seen and the ***string of*** `T` not yet seen while using the iterator.

For-Each Loops

- Since `List<T>` extends the interface `Iterable`, you may write a ***for-each loop*** to "see" all elements of `List<T> s` :

```
for (T x : s) {
   // do something with x, but do
   // not call methods on s or
   // change the value of x
}
```

For-E

- Since `List<T>` … `Iterable`, yo… ***loop*** to "see" all elements of `List<T> s` :

```
for (T x : s) {
  // do something with x, but do
  // not call methods on s or
  // change the value of x
}
```

This declares `x` as a local variable of type `T` in the loop; on each iteration, `x` is ***aliased*** to a different element of `s`.

For-E

- Since `List<T>` … `Iterable`, you … ***loop*** to "see" all elements of `List<T> s` :

```
for (T x : s) {
   // do something with x, but do
   // not call methods on s or
   // change the value of x
}
```

The restrictions on what you may do with `x` and `s` in the loop body are *critical*; do not forget about them!

How a For-Each Loop Works

- The for-each loop above is actually ***syntactic sugar*** for the following code:

```
Iterator<T> it = s.iterator();
while (it.hasNext()) {
  T x = it.next();
  // do something with x, but do
  // not call methods on s or
  // change the value of x
}
```

How a For-

The `iterator` method for `List<T>` returns a value of type `Iterator<T>`.

- The for-each loop is ***syntactic sugar*** for the following code:

```
Iterator<T> it = s.iterator();
while (it.hasNext()) {
  T x = it.next();
  // do something with x, but do
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  // change the value of x
}
```

How a For-

The `hasNext` and `next` methods of this `Iterator<T>` variable are used in the iteration.

- The for-each loop is ***syntactic sugar*** for the following code:

```
Iterator<T> it = s.iterator();
while (it.hasNext()) {
  T x = it.next();
  // do something with x, but do
  // not call methods on s or
  // change the value of x
}
```

Iterating With `iterator`

- This code has the following properties:
  - It introduces aliases, so you must be careful to "follow the rules"; specifically, the loop body should not call any methods on `s`
  - If what you want to do to each element is to change it (when `T` is a mutable type), then the approach does not work because the loop body should not change the value of `x`
    - With `List`, you could just use the kernel methods to visit the entries in the same order

The `Iterator<T>` Interface

- For the `iterator` method, the kernel class returns a reference to an instance of a ***nested class*** (`List2Iterator`) that implements the `Iterator<T>` interface
- The code in that class implements these methods:
  - `boolean hasNext()`
  - `T next()`
  - `void remove()`

The Itera

- For the iterat
  class returns a r
  a ***nested class*** (Lis erator) that
  implements the It tor<T> interface
- The code in that ss implements these
  methods:
  - **boolean** asNext()
  - T next()
  - **void** remove()

The remove method is described as "optional" in the interface Iterator<T>, and we do not implement it because it can cause serious problems.

hasNext

boolean hasNext()

- Returns **true** iff the iteration has more elements (i.e., there are any "unseen" elements).
- Ensures:

hasNext = (~this.unseen /= < >)

next

`T next()`

- Returns the next element in the iteration (i.e., the next "unseen" element, which becomes a "seen" element).
- Aliases: reference returned by `next`
- Updates: **`~this`** (i.e., the iterator, not the collection)
- Requires:

  ~this.unseen `/= < >`
- Ensures:

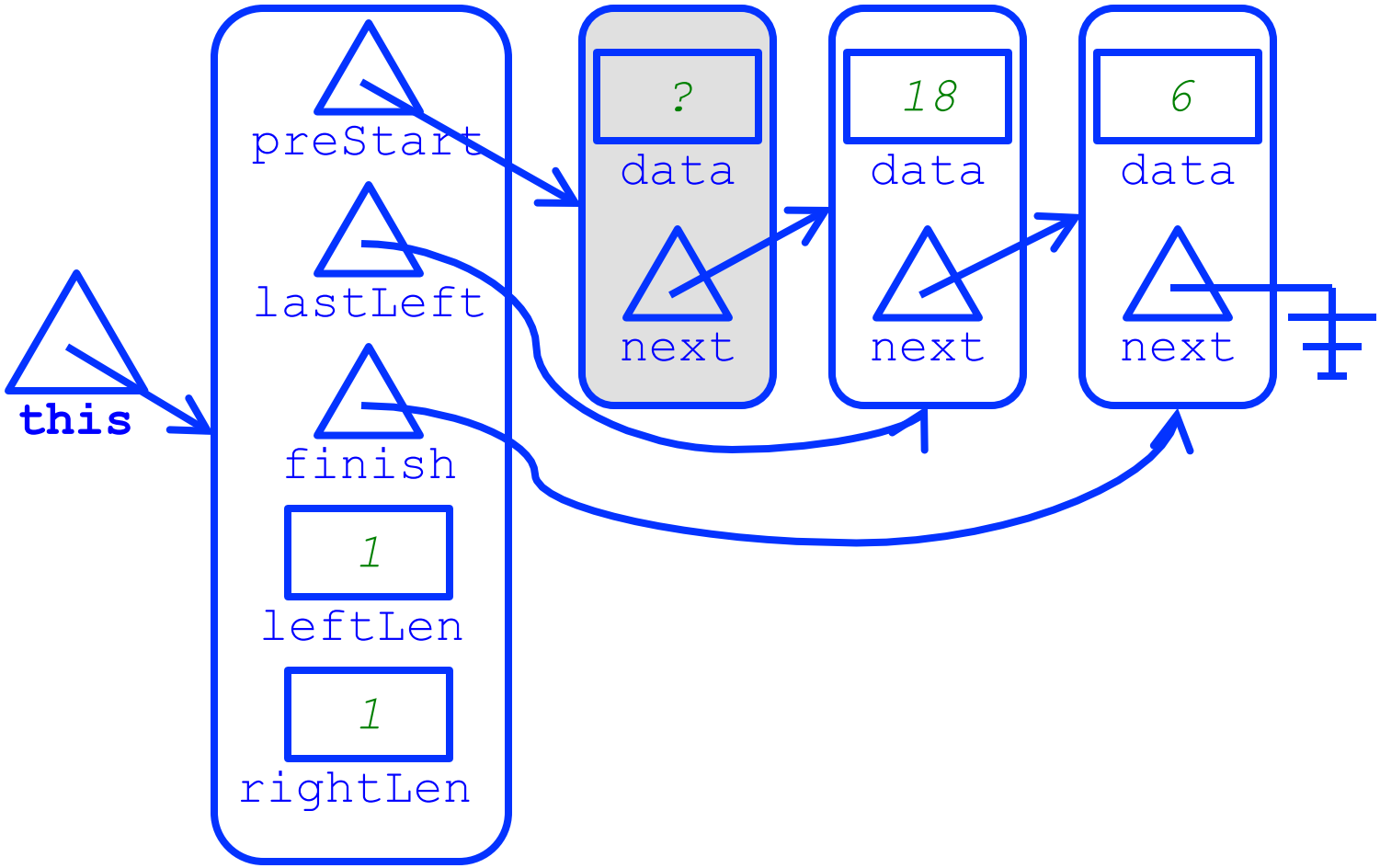
  ~this.seen `*` ***~this.unseen*** `=`

  #~this.seen `*` ***#~this.unseen*** ***and***

  ~this.seen `=` ***#~this.seen*** `* <next>`

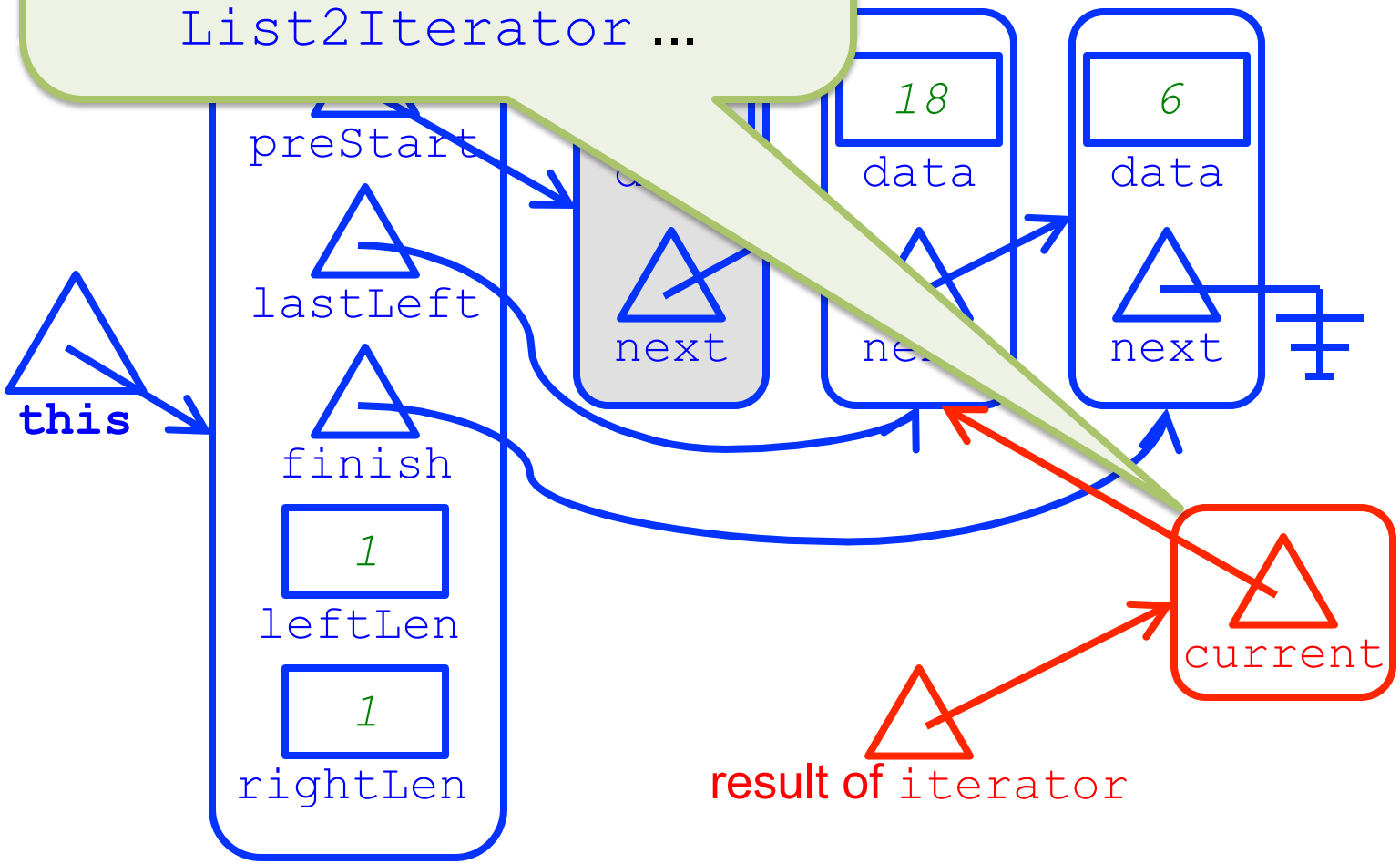
Iterator for `List2`

this = *(<18>, <6>)*



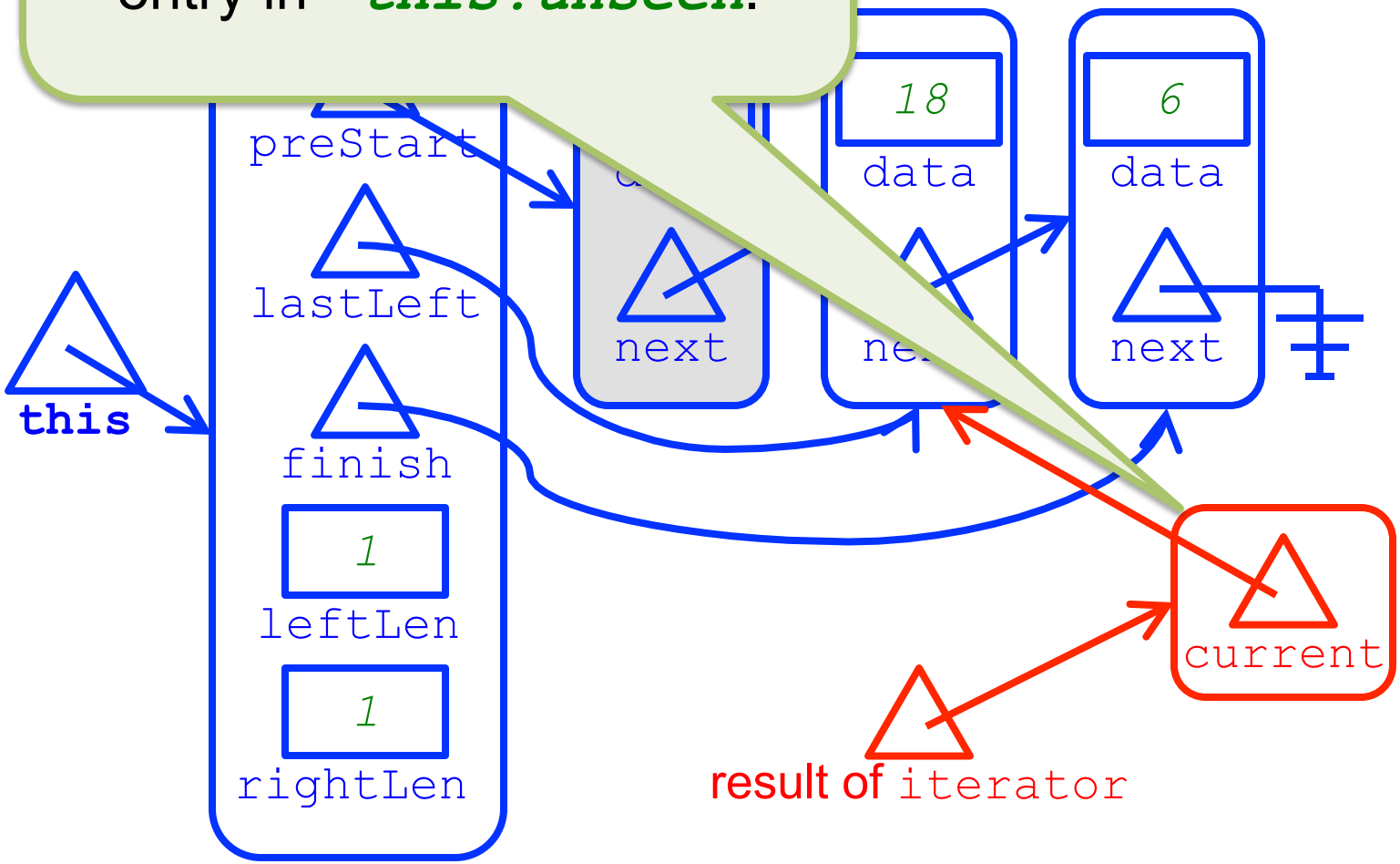
r List2

The object created by a call to `iterator` is an instance of the ***nested class*** `List2Iterator` ...



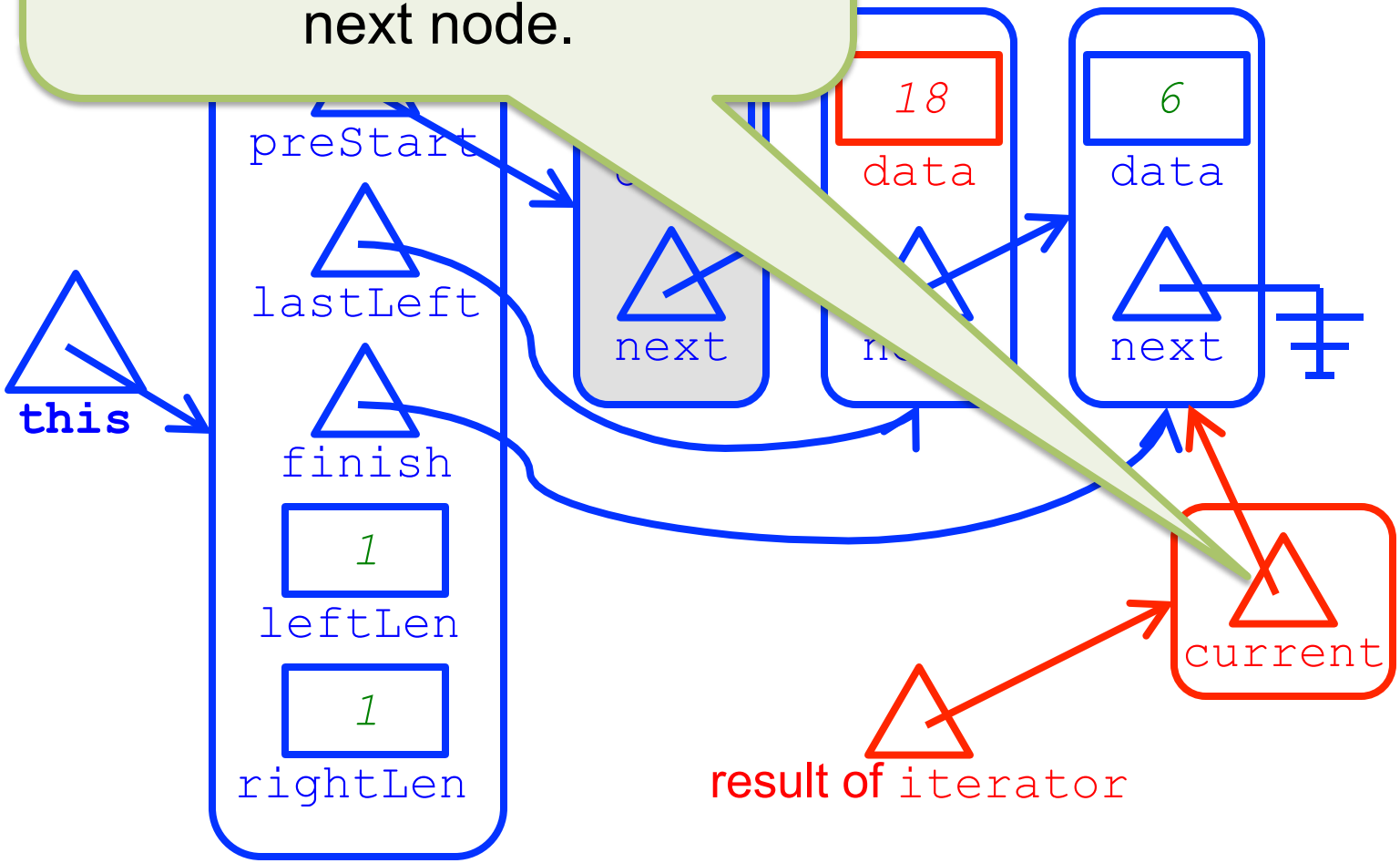
r List2

... and it holds a reference to the node that has the first entry in ***~this.unseen***.



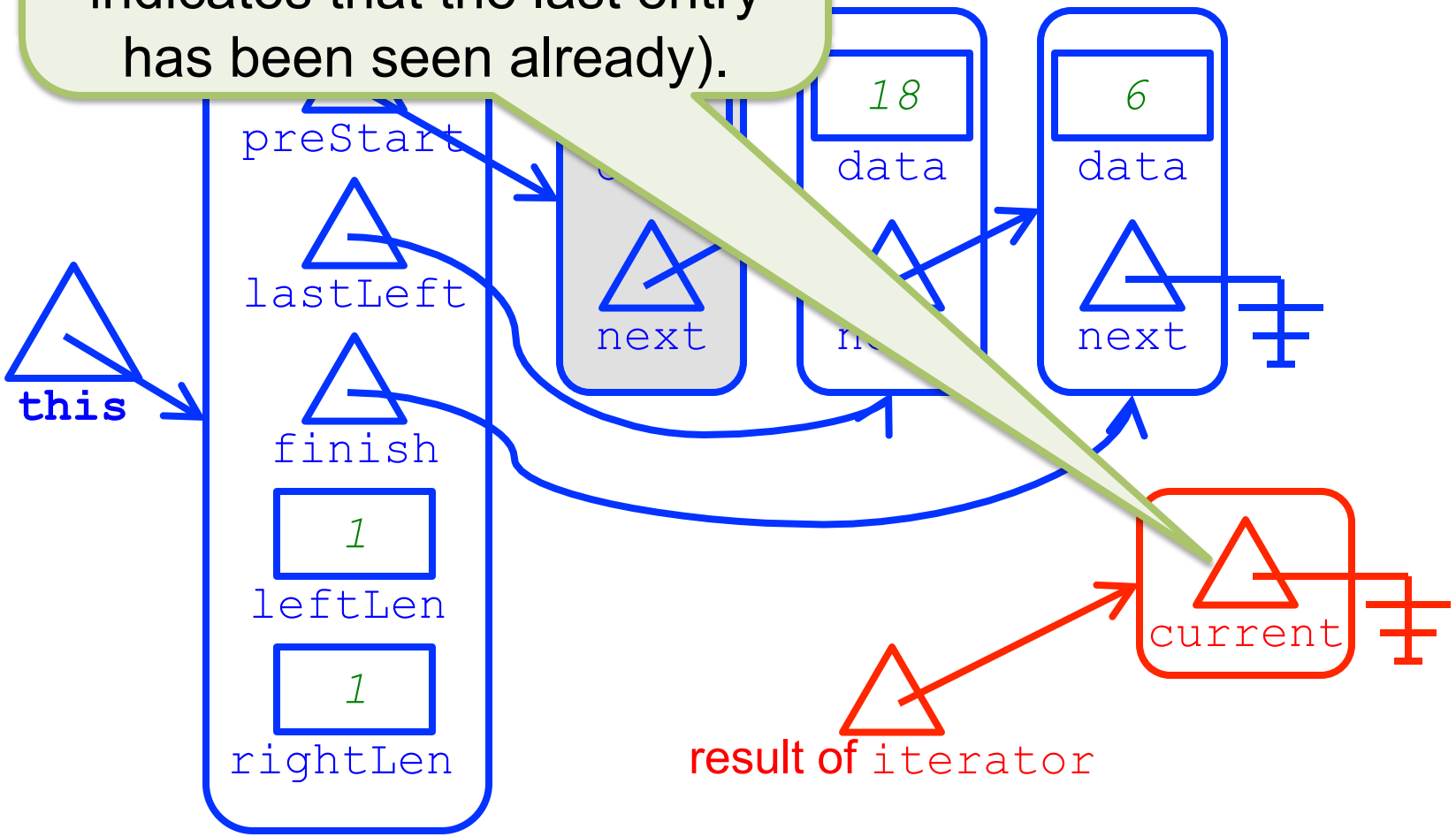
r List2

The next method returns the data in that node, also advancing current to the next node.



r List2

The `hasNext` method checks whether `current` is **`null`** (which, in this case, indicates that the last entry has been seen already).



A New Java Issue

- In the code inside the nested class `List2Iterator`, there are two references named **`this`**, so the name is ambiguous!
  - The name **`this`** denotes the object of type `List2Iterator` (the nested class)
  - The qualified name `List2.`**`this`** denotes the object of type `List2` (the enclosing class)
- See this line of code in the `List2Iterator` constructor:

```
this.current = List2.this.preFront.next;
```

The class `List2Iterator` has an instance variable named `current`, and this is it.

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- See this line of code in the `List…Iterator` constructor:

```
this.current = List2.this.preFront.next;
```

The class `List2` has an instance variable named `preFront`, and this is it.

Resources

- Java Libraries API: `Iterable` and `Iterator`
  - http://docs.oracle.com/javase/7/docs/api/