Iterators

What is an Iterator?

An ***iterator*** is an abstract data type that allows us to iterate through the elements of a collection one by one

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Operations

- next: next element of the collection; ERROR if the element does not exist
- hasNext: true if there are more elements in the collection; false otherwise
- remove: removes the last element returned by the iterator

Consider an iterator for a collection storing the following elements:

Consider an iterator for a collection storing the following elements:

next:

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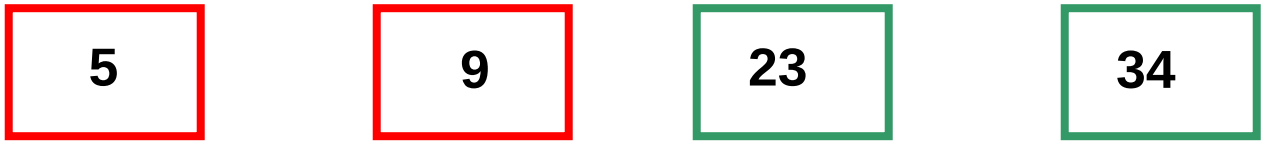

next:

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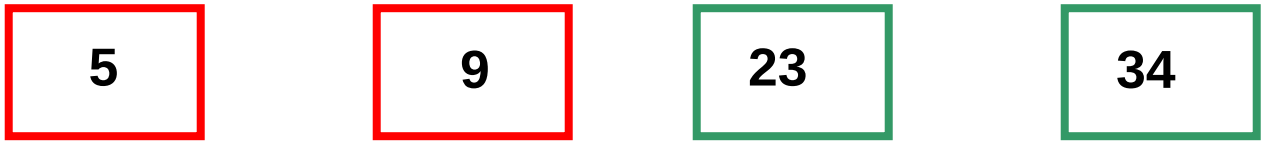

hasNext:

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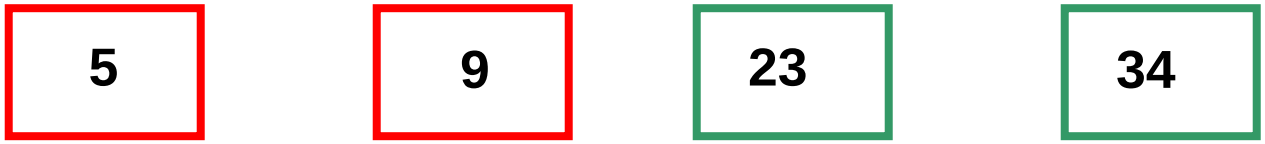
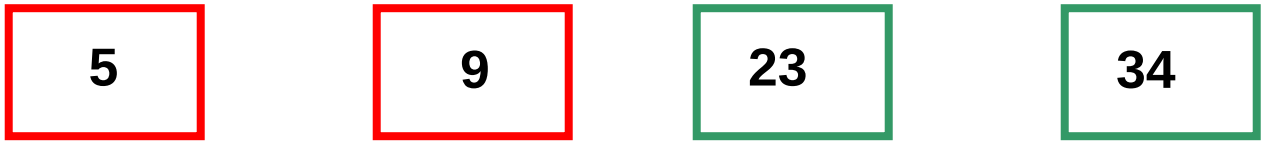


hasNext: true

Consider an iterator for a collection storing the following elements:



remove

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next:

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next:

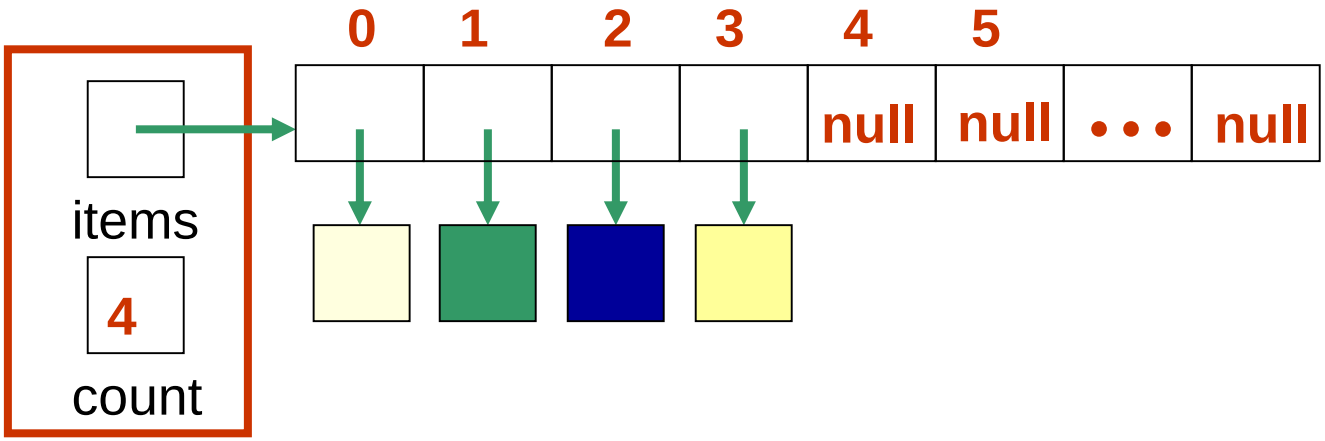
Iterator Interface

```
public interface Iterator<T> {
    public boolean hasNext( );
    public T next( );
    public void remove( ); // (optional operation)
}
```

It is in the java.util package of the Java API

Array Iterator

Consider a collection of data items stored in an array



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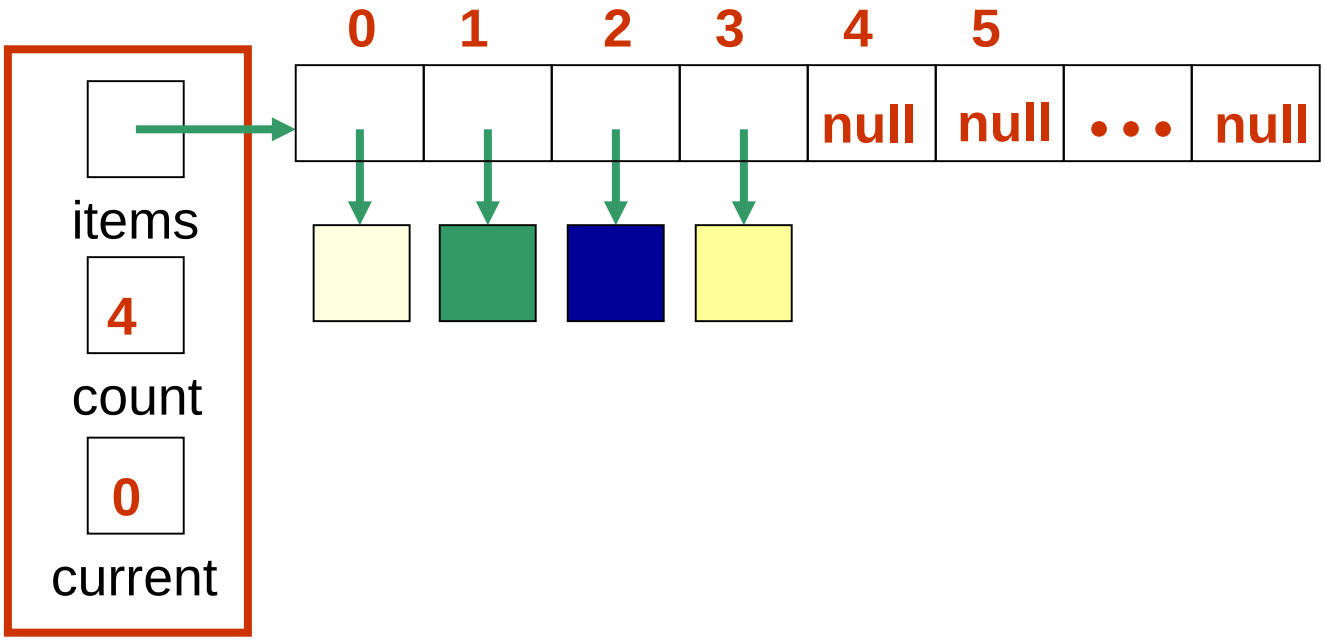

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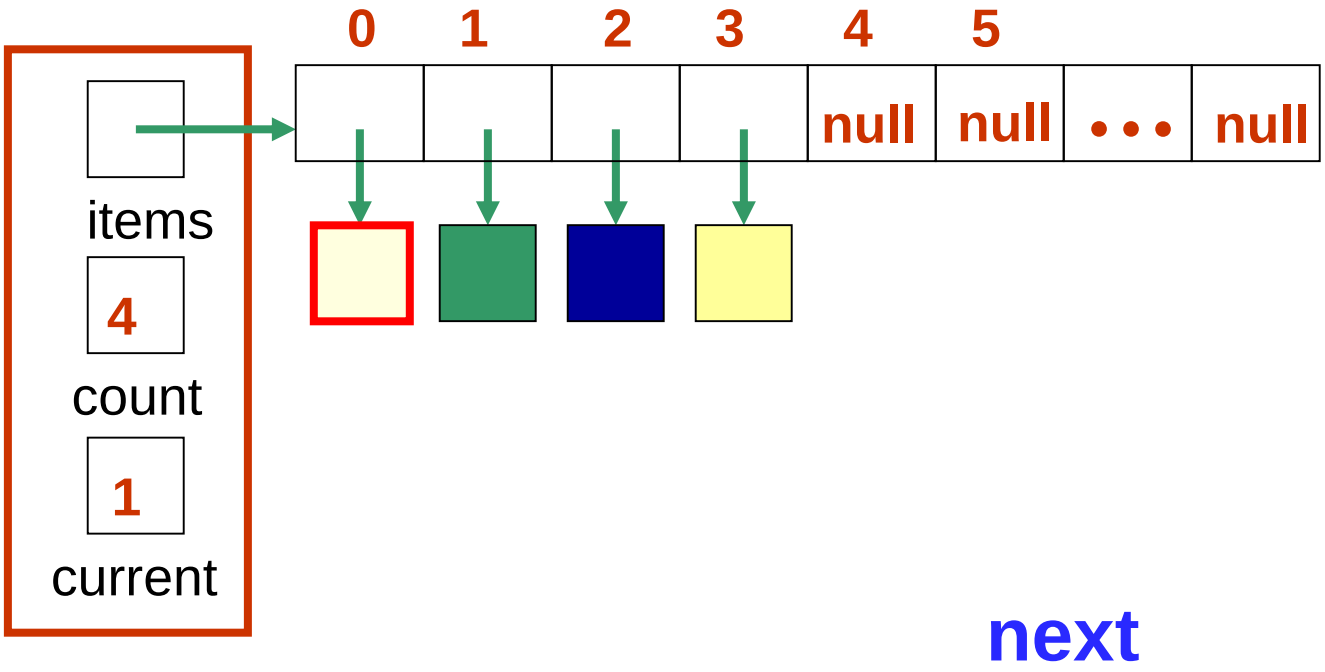


```
// Represents an iterator over the elements of an array
import java.util.*;
public class ArrayIterator<T> implements Iterator<T> {

    // Attributes
    private int count;   // number of elements in collection
    private int current; // current position in the iteration
    private T[ ] items;   // items in the collection

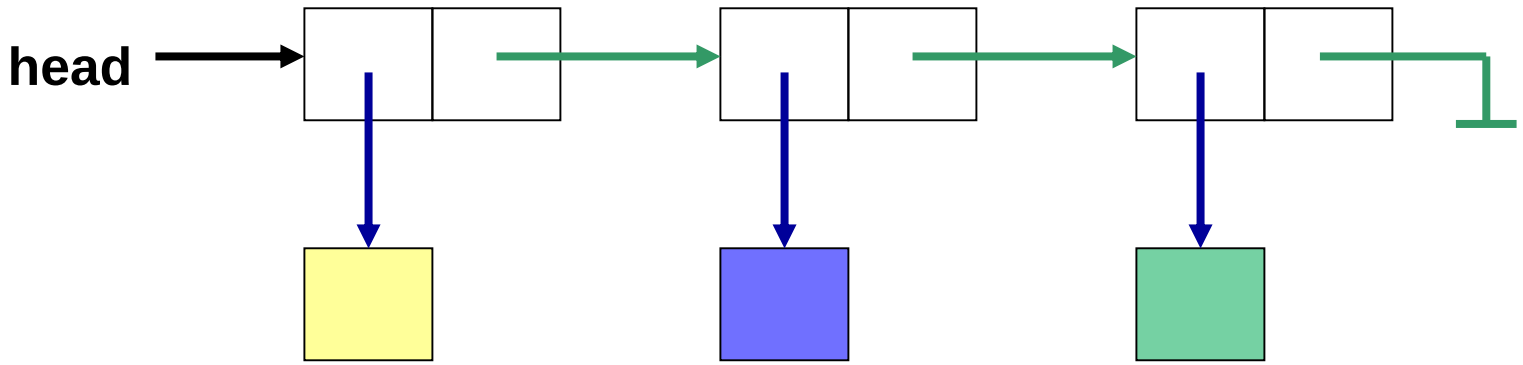
    // Constructor: sets up this iterator using the
    // specified items
    public ArrayIterator (T[ ] collection, int size) {
        items = collection;
        count = size;
        current = 0;
    }
```

```
    // Returns true if this iterator has at least one
    // more element to deliver in the iteration
    public boolean hasNext( )  {
          return (current < count);
    }

    // Returns the next element in the iteration.
    // If there are no more elements in this iteration,
    // throws an exception.
    public T next( )  {
        if (! hasNext( ))
          throw new NoSuchElementException( );
        current++;
        return items[current - 1];
     }
}
```

Linked Iterator

Consider a collection of data items stored in a linked list.



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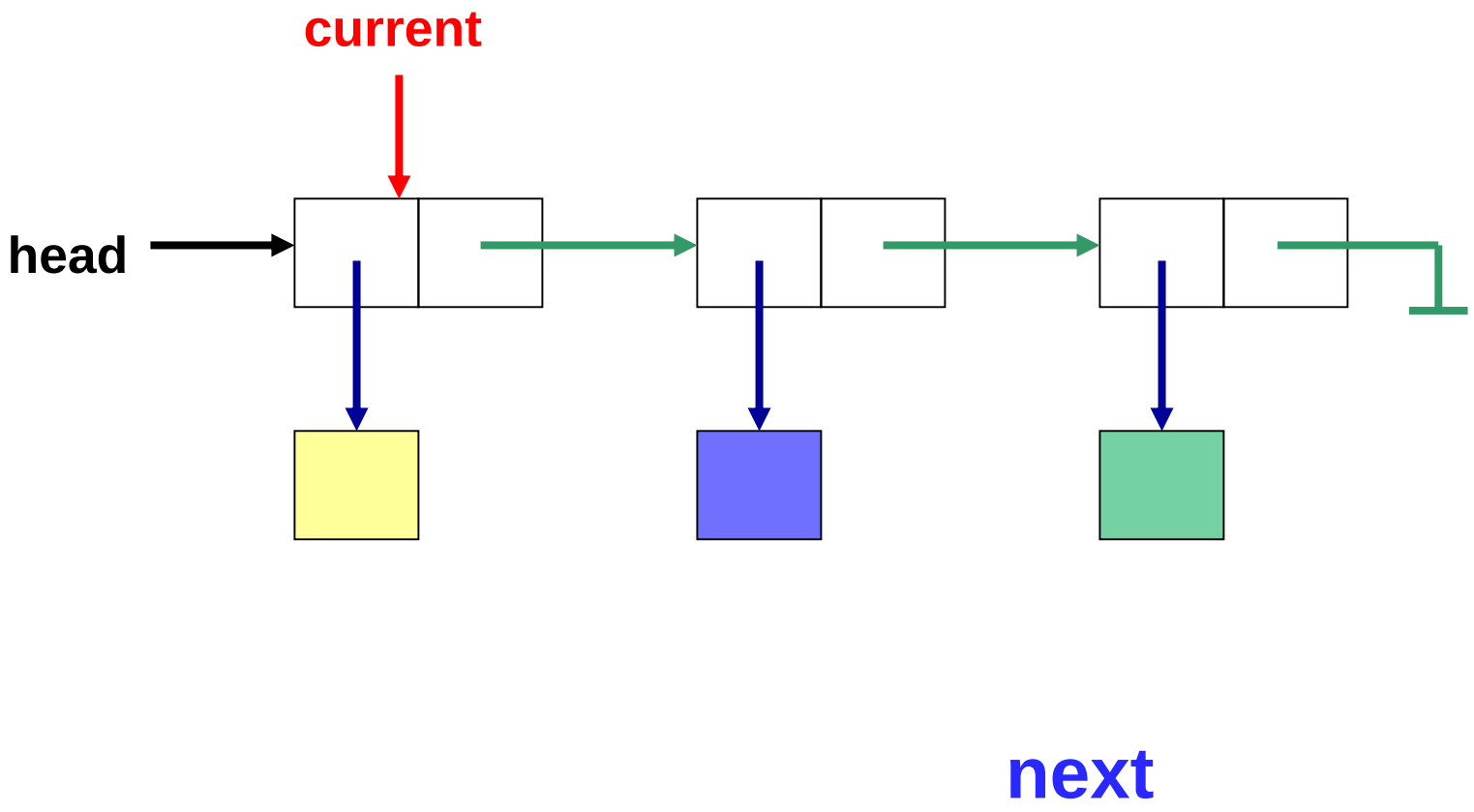

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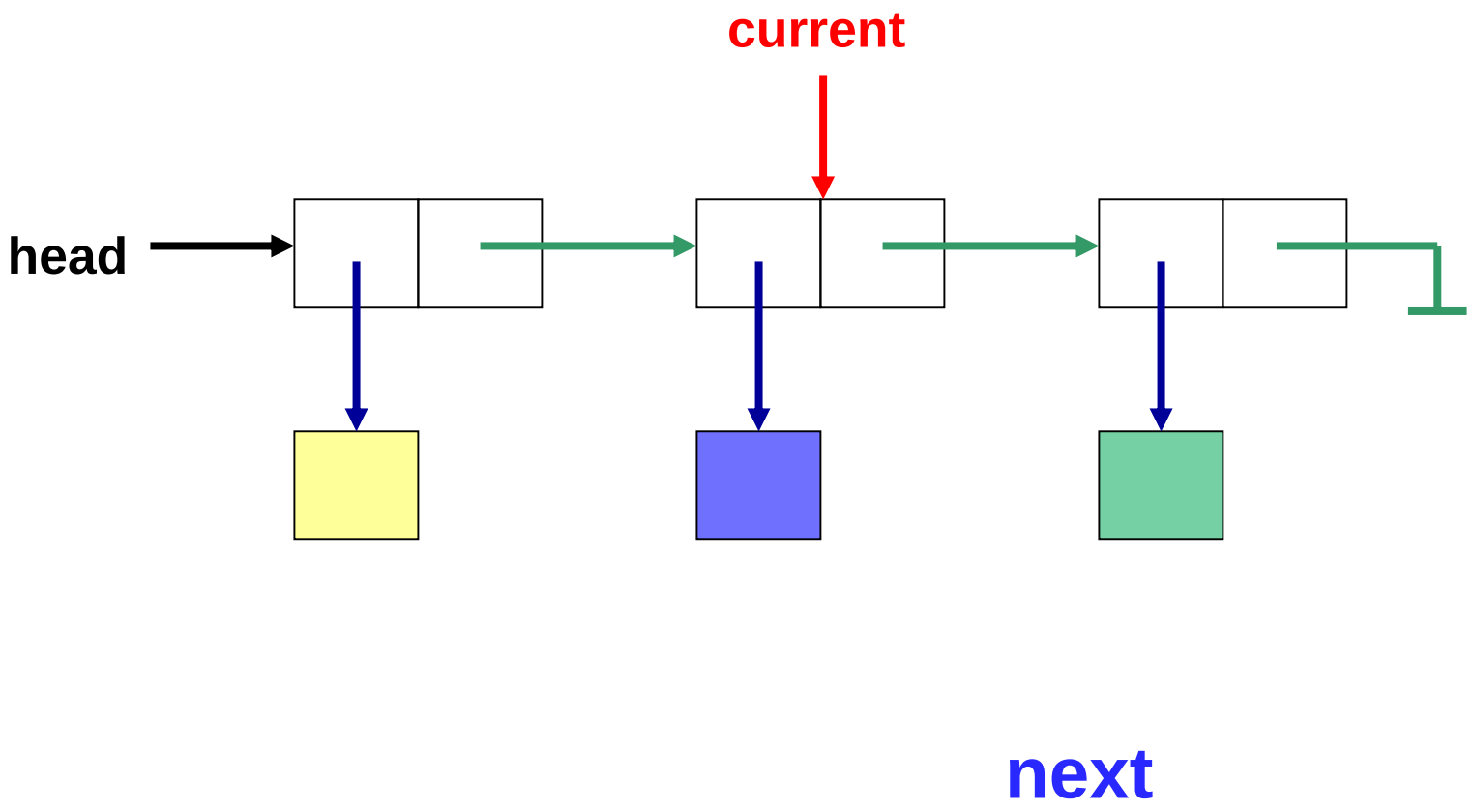

```
import java.util.*;
public class LinkedIterator<T> implements Iterator<T> {

  // Attributes
   private LinearNode<T> current; // current position

   //  Constructor: Sets up this iterator
   public LinkedIterator (LinearNode<T> collection){
          current = collection;
}
```

```
    //  Returns true if this iterator has at least one more element
    //  to deliver in the iteration.
    public boolean hasNext( ) {
       return (current != null);
    }
    //  Returns the next element in the iteration. If there are no
    //  more elements in this iteration, throws an exception.
    public T next( ) {
       if (! hasNext( ))
            throw new NoSuchElementException( );
       T result = current.getElement( );
       current = current.getNext( );
       return result;
    }
}
```

Iterators for a Collection

A List ADT can be implemented using, for example, an array or a linked list. For each implementation we can add an iterator operation that returns an iterator for the corresponding list.

iterator method for ArrayList

```
/**
* Returns an iterator for the elements currently in this list.
*
* @return  an iterator for the elements in this list
*/
   public Iterator<T> iterator()  {
      return new ArrayIterator<T> (list, size);
   }
```

iterator method for ArrayList

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/**
* Returns an iterator for the elements currently in this list.
*
* @return  an iterator for the elements in this list
*/
   public Iterator<T> iterator()  {
      return new ArrayIterator<T> (list, size);
   }
```

An application can then declare an iterator as

```
ArrayList<String> a = new ArrayList<String>();
. . .
Iterator<String> iter = a.iterator();
```

iterator method for LinkedList

```
/**
* Returns an iterator for the elements currently in this list.
* @return  an iterator for the elements in this list
*/
public Iterator<T> iterator( ) {
   return new LinkedIterator<T> (list);
}
```

An application can declare an iterator as

```
LinkedList<String> list = new LinkedList<String>();
. . .
Iterator<String> iter = list.iterator();
```

Using an Iterator in an Application

If we want to print the elements in the iterator we can use this code:

```
while(iter.hasNext()) {
        System.out.println(iter.next());
}
```

This will work regardless of whether iter was obtained from theArrayList or from the LinkedList!

Why use Iterators?

- Traversing through the elements of a collection is very common in programming, and iterators provide a *uniform* way of doing so.
- Advantage? Using an iterator, we don't need to know how the collection is implemented!