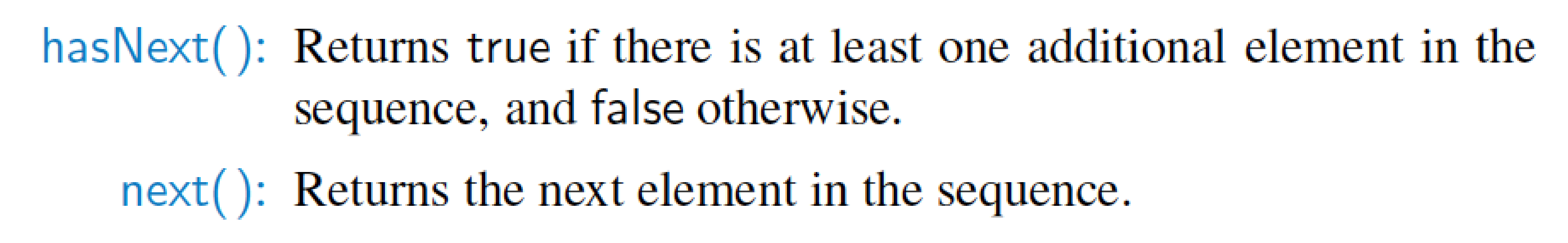
CH7.
LIST AND ITERATOR ADTS

ACKNOWLEDGEMENT: THESE SLIDES ARE ADAPTED FROM SLIDES PROVIDED WITH DATA STRUCTURES AND ALGORITHMS IN JAVA, GOODRICH, TAMASSIA AND GOLDWASSER (WILEY 2016)

ITERATORS

- An **iterator** is a software design pattern that abstracts the process of scanning through a sequence of elements, one element at a time.



hasNext(): Returns true if there is at least one additional element in the sequence, and false otherwise.

next(): Returns the next element in the sequence.

- Some iterators offer a third operation: `remove()` to modify the data structure while scanning its elements

USES OF ITERATORS

- Abstracts a series or collection of elements
  - A container, e.g., List or PositionalList
  - A stream of data from a network or file
  - Data generated by a series of computations, e.g., random numbers
- Facilitate generic programming of algorithms to operate on any source of data, e.g., finding the minimum element in the data
- Why?
  - While it is true we could just reimplement minimum as many times as needed, it is better to use a trusted single implementation for: (1) correctness – no silly typos and (2) efficiency – professional libraries are often better than what you could implement on your own.

THE ITERABLE INTERFACE

- Java defines a parameterized interface, named **Iterable**, that includes the following single method:
  - `iterator()`: Returns an iterator of the elements in the collection.
- An instance of a typical collection class in Java, such as an `ArrayList`, is `Iterable` (but not itself an iterator); it produces an iterator for its collection as the return value of the `iterator()` method.
- Each call to `iterator()` returns a new iterator instance, thereby allowing multiple (even simultaneous) traversals of a collection.

EXAMPLE IN PSEUDOCODE

- The following algorithm will compute the minimum of an iterable collection:

```
Algorithm minimum
Input: Iterable collection $I$ of comparable Elements
Iterator $it \leftarrow I$.iterator()
Element $min \leftarrow$ null
while $it$.hasNext() do
    Element $e \leftarrow it$.next()
    if $e$.compareTo($min$) $< 0$ then
        $min \leftarrow e$
return $min$
```

EXAMPLE IN JAVA

- The following code will compute the minimum of an Iterable collection:

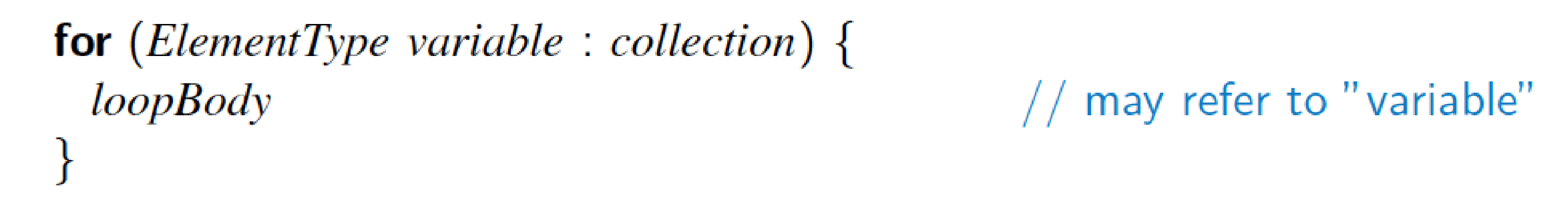
```java
public static <E extends Comparable<E>> E minimum(
        Iterable<E> iterable) {
    Iterator<E> it = iterable.iterator();
    E min = null;
    while(it.hasNext()) {
      E e = it.next();
      if(e.compareTo(min) < 0)
        min = e;
    }
    return min;
}
```

EXERCISE

- Write an algorithm and a Java program using iterators to compute whether a collection contains only unique elements.
    - Test your generic method with both a Java ArrayList and a Java LinkedList

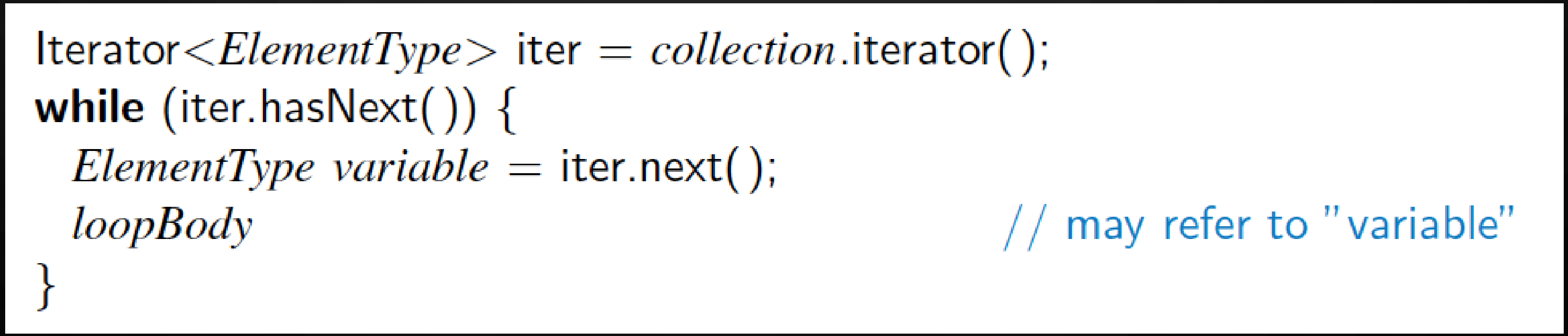
THE FOR-EACH LOOP

- Java's Iterable class also plays a fundamental role in support of the "for-each" loop syntax:



```
for (ElementType variable : collection) {
  loopBody                                   // may refer to "variable"
}
```

  - is equivalent to:



```
Iterator<ElementType> iter = collection.iterator( );
while (iter.hasNext( )) {
  ElementType variable = iter.next( );
  loopBody                                   // may refer to "variable"
}
```

EXAMPLE IN PSEUDOCODE

- The following algorithm will compute the minimum of an iterable collection:

```
Algorithm minimum
Input: Iterable collection $I$ of comparable Elements
Element $min \leftarrow$ null
for all Element e $\in I$ do
    if $e$.compareTo($min$) $< 0$ then
        $min \leftarrow e$
return $min$
```

EXAMPLE IN JAVA

- The following code will compute the minimum of an Iterable collection:

```
public static <E extends Comparable<E>> E minimum(
        Iterable<E> iterable) {
    E min = null;
    for(E e : iterable) {
        if(e.compareTo(min) < 0)
            min = e;
    }
    return min;
}
```

EXERCISE

- Simplify your algorithm and Java program using the for-each loop construct to determine whether a collection contains only unique elements.

FOR-EACH VS ITERATORS

- For-each is not always a replacement for iterators
  - In fact it only replaces the most common use of iterators – iterating entirely through a collection
  - When you can't use a for-each loop, use iterators
    - Essentially, when you need more power, use more power
- Remember this is about generic programming. Iterators abstract the underlying collection. When you know your collection, you might be able to do something different.