Java Collection 2

Wednesday, November 10, 2021 11:17 PM

Java_Coll...

Java Collection Framework

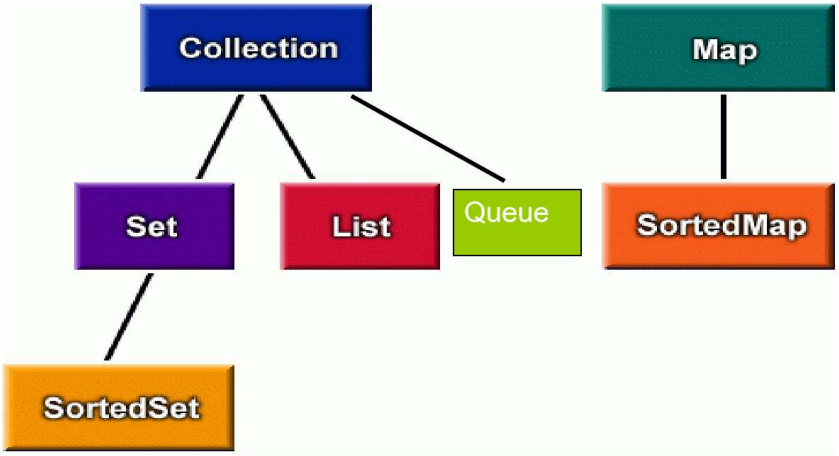
Collection Framework

- A *collection framework* is a unified architecture for representing and manipulating collections. It has:
  - **Interfaces:** abstract data types representing collections
  - **Implementations:** concrete implementations of the collection interfaces
  - **Algorithms:** methods that perform useful

computations, such as searching and sorting

- These algorithms are said to be *polymorphic*: the same method can be used on different implementations

Collection interfaces

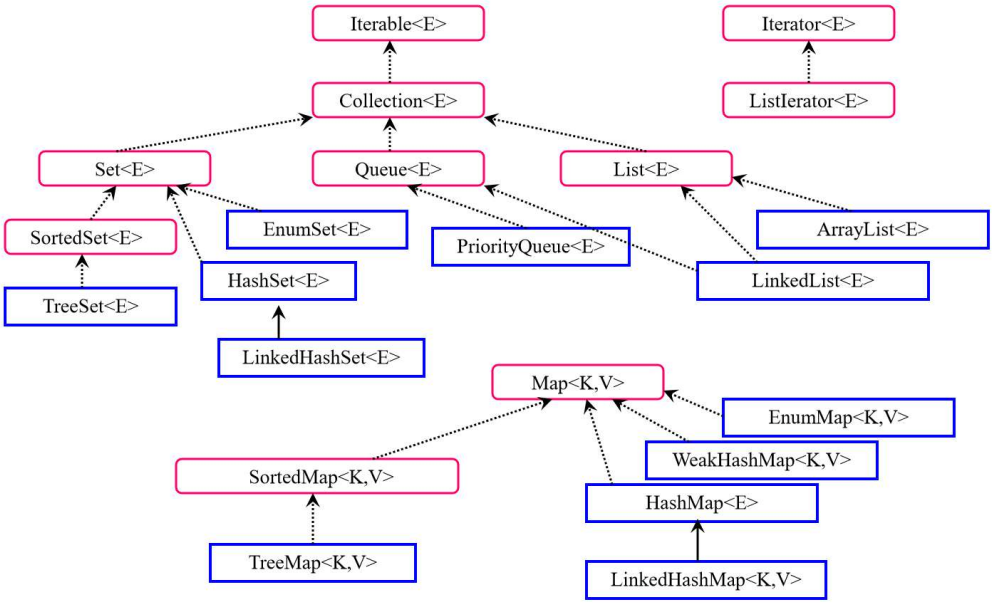


Collection Interface continued

- **Set →**
  - The familiar set abstraction.
  - No duplicates; May or may not be ordered.
- **List →**
  - Ordered collection, also known as a sequence.
  - Duplicates permitted; Allows positional access
- **Map →**
  - A mapping from keys to values.

- Each key can map to at most one value (function).
- The keys are like indexes. In List, the indexes are integer. In Map, the keys can be any objects.
- **Queue →**
- Ordered collection. FIFO (First In First Out)

Type Trees for Collections



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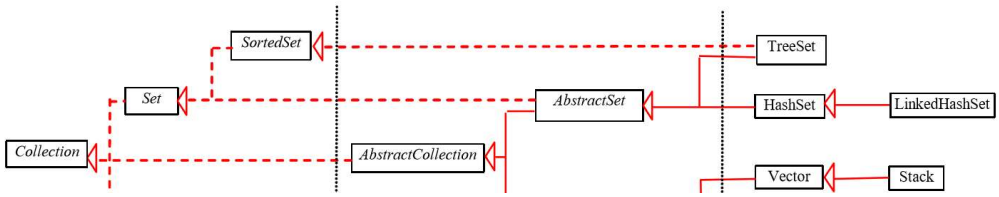
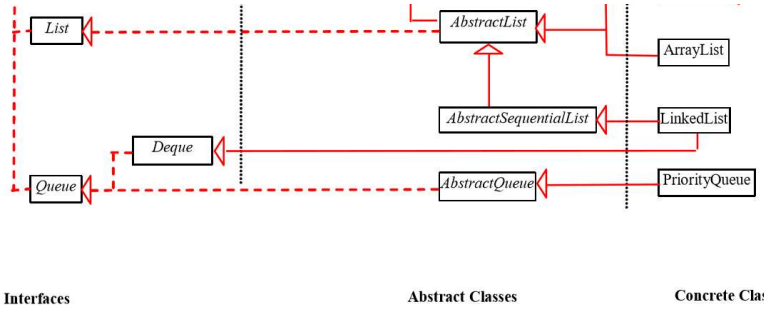
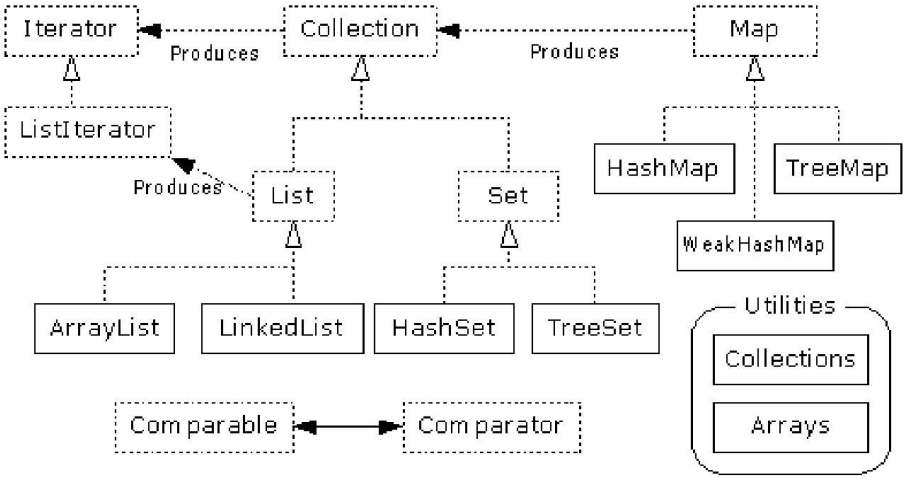
Java Collection Framework hierarchy, cont.

Set and List are subinterfaces of Collection.





Collections Framework Diagram



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Collection Interface

- Defines fundamental methods
  - **int size();**
  - **boolean isEmpty();**
  - **boolean contains(Object element);**
  - **boolean add(Object element); // Optional**

- **boolean remove(Object element); // Optional**
- **Iterator iterator();**

- These methods are enough to define the basic behavior of a collection
- Provides an Iterator to step through the elements in the Collection

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Interface `Collection`

`add(o)`	Add a new element
`addAll(c)`	Add a collection
`clear()`	Remove all elements
`contains(o)`	Membership checking.
`containsAll(c)`	Inclusion checking
`isEmpty()`	Whether it is empty
`iterator()`	Return an iterator
`remove(o)`	Remove an element
`removeAll(c)`	Remove a collection
`retainAll(c)`	Keep the elements
`size()`	The number of elements

Iterator Interface

- Defines three fundamental methods
  - **Object next()**
  - **boolean hasNext()**
  - **void remove()**
- These three methods provide access to the

contents of the collection

- An Iterator knows position within collection
- Each call to next() "reads" an element from the collection
  - Then you can use it or remove it

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Iterator Position

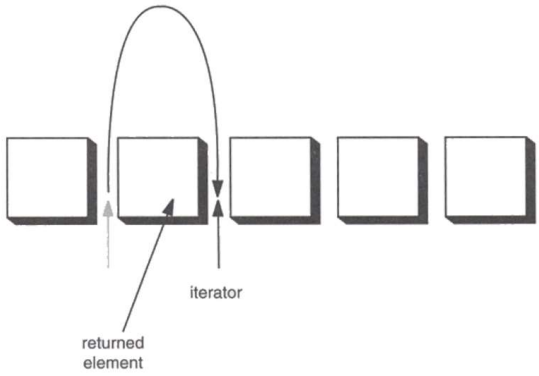

Figure 2–3: Advancing an iterator

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Example - SimpleCollection

```
public class SimpleCollection  {
   public static void main(String[] args) {
      Collection c;
      c = new ArrayList();
      System.out.println(c.getClass().getName());
```

Quick Access → index

ArrayList

TreeSet → no duplicates

Interface type LHS

TreeSet() ; data

→ Implementation → Understanding

```
for (int i=1; i <= 10; i++) {
        c.add(i + " * " + i + " = "+i*i);
}
Iterator iter = c.iterator();
while (iter.hasNext())
        System.out.println(iter.next());
}
```

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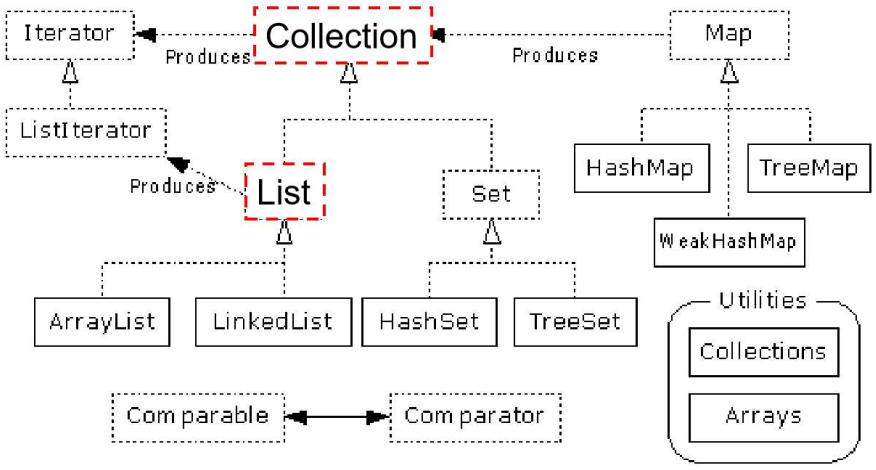
List Interface Context



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List Interface

- The List interface adds the notion of *order* to a collection
- The user of a list has control over where

an element is added in the collection
- Lists typically allow *duplicate* elements
- Provides a ListIterator to step through the elements in the list.

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ListIterator Interface

- Extends the Iterator interface
- Defines three fundamental methods
  - **void add(Object o)** - before current position
  - **boolean hasPrevious()**
  - **Object previous()**
- The addition of these three methods defines the basic behavior of an ordered list
- A ListIterator knows position within list

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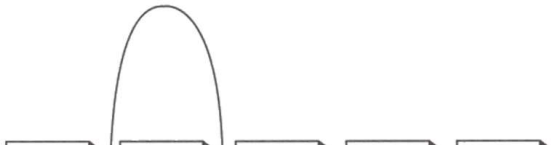
Iterator Position - `next()`, `previous()`



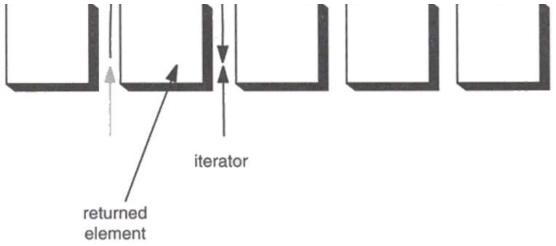


Figure 2–3: Advancing an iterator

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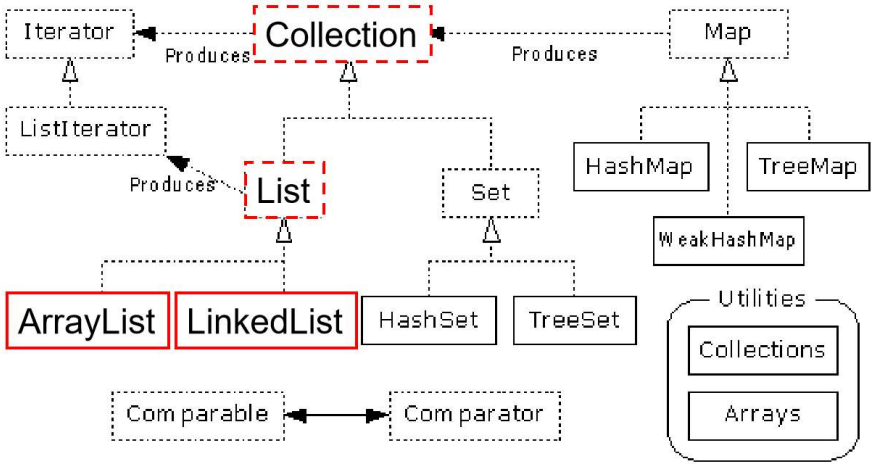
ArrayList and LinkedList Context



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List Implementations

- ArrayList
  - low cost random access
  - high cost insert and delete

- high cost insert and delete
- array that resizes if need be

- LinkedList
  - sequential access
  - low cost insert and delete
  - high cost random access

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ArrayList overview

- Constant time positional access (it's an array)
- One tuning parameter, the initial capacity

```
public ArrayList(int initialCapacity) {
   super();
   if (initialCapacity < 0)
        throw new IllegalArgumentException(
                "Illegal Capacity: "+initialCapacity);
   this.elementData = new Object[initialCapacity];
}
```

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ArrayList methods

- The indexed get and set methods of the List interface are appropriate to use since ArrayLists are backed by an array
  - Object get(int index)

- ~~Object get(int index)~~
- **Object set(int index, Object element)**

- Indexed add and remove are provided, but can be costly if used frequently
  - **void add(int index, Object element)**
  - **Object remove(int index)**
- May want to resize in one shot if adding many elements
  - **void ensureCapacity(int minCapacity)**

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LinkedList overview

- Stores each element in a node
- Each node stores a link to the next and previous nodes
- Insertion and removal are inexpensive
  - just update the links in the surrounding nodes
- Linear traversal is inexpensive
- Random access is expensive
  - Start from beginning or end and traverse each node while counting

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LinkedList methods

- The list is sequential, so access it that way
  - **ListIterator listIterator()**
- ListIterator knows about position

- use **add()** from ListIterator to add at a position
- use **remove()** from ListIterator to remove at a position

- LinkedList knows a few things too
  - **void addFirst(Object o), void addLast(Object o)**
  - **Object getFirst(), Object getLast()**
  - **Object removeFirst(), Object removeLast()**

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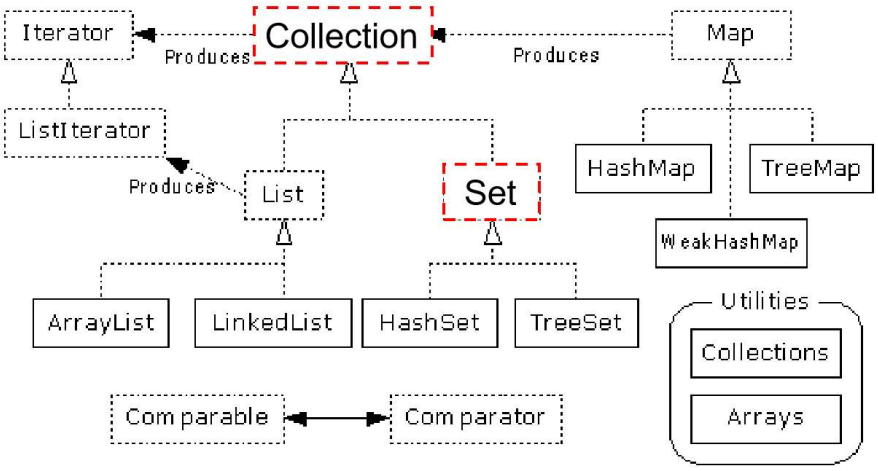
Set Interface Context



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Set Interface

- Same methods as Collection
  - different contract - no duplicate entries

- Defines two fundamental methods
  - **boolean add(Object o)** - reject duplicates
  - **Iterator iterator()**
- Provides an Iterator to step through the elements in the Set
  - No guaranteed order in the basic Set interface
  - There is a SortedSet interface that extends Set

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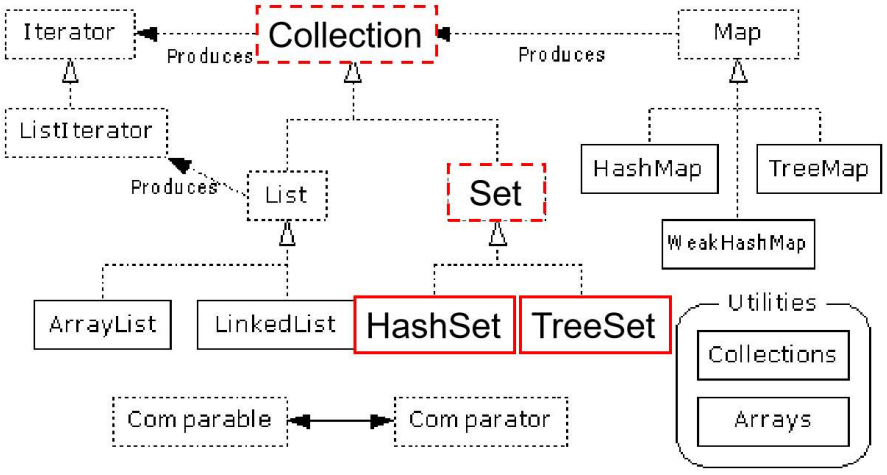
HashSet and TreeSet Context



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HashSet

- Find and add elements very quickly
- uses hashing implementation in HashMap

- uses hashing implementation in HashMap
- Hashing uses an array of linked lists
  - The **hashCode()** is used to index into the array
  - Then **equals()** is used to determine if element is in the (short) list of elements at that index
- No order imposed on elements
- The **hashCode()** method and the **equals()** method must be compatible
  - if two objects are equal, they must have the same **hashCode()** value

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TreeSet

- Elements can be inserted in any order
- The TreeSet stores them in order
  - Red-Black Trees out of Cormen-Leiserson-Rivest
- An iterator always presents them in order
- Default order is defined by natural order
  - objects implement the Comparable interface
  - TreeSet uses **compareTo(Object o)** to sort
- Can use a different Comparator
  - provide Comparator to the TreeSet constructor

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Map Interface Context