

The java collection framework

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January 28, 2019

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Collections

The basic collections, well known in programming frameworks are:

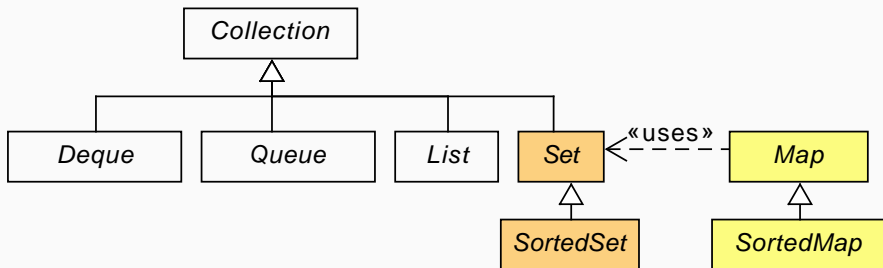
LIST An ordered collection of elements. The elements are ordinarily ordered in **insertion** or **add** order.

STACK A Last in First out ordered collection. The collection can only be access at the “top”. You know that one already.

QUEUE A First in First Out ordered data structure. The elements are added (typically called tail) only at one end and can be retrieved from the other end (called head). (NL:Wachtrij, DE:Warteschlange).

- BAG** An unordered collection. Things can go in and come out. The bag provides no stricter constraints on storage.
- SET** A collection in which every element is unique. It is mostly comparable to a mathematical set (NL:Verzameling, DE:Menge). A set will typically provide method that support the mathematical concepts of union, difference and add.
- MAP** otherwise known as a dictionary. A map provides a “mapping” from a key to a value, where you can use the key to look up (get) the value from the map. By definitions, the keys in a MAP form a set. Typically this key-set can be obtained from the map.

- A collections framework is a unified architecture for representing and manipulating collections. Collections frameworks contain the following: interfaces, implementations, algorithms.
- The top most interface is `Collection`. This interface declares almost all operations¹ of all collections, leaving some of the operations optional.
 - For one it declares that all collections should be `Iterable`, which allows the use of the for-each construct as in `for(E e : collection)`.
- The core collection interfaces



Methods

- The Collection interface provides basic adding and removing operations like: `addAll`, `add`, `remove`, `removeAll`
- The interface provides query operations like: `size`, `contains`, `isEmpty`
- The interface provide the `toArray()` method
- Also the `forEach()` method is provided, instead of using an iterator you can apply lambda expressions to iterate over the collection.

Iterators

- Each collection is `Iterable`
- Obtain an iterator, example: `Iterator<> iterator = collection.iterator();`

Traversing Collections

There are three ways to traverse collections:

using aggregate operations

```
list.forEach(e -> System.out.println(e));
```

with the for-each construct

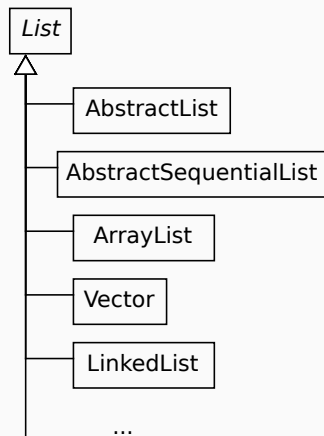
```
for (Object o : c) {  
    System.out.println(o);  
}
```

using Iterators

```
Iterator<String> it = c.iterator();  
while (it.hasNext()) {  
    System.out.println(it.next());  
}
```

Rich set of implementations

- Interfaces have multiple implementations, because one cannot always make “one size to fit all”.
- E.g. The `List` has the following implementing classes: `AbstractList`, `AbstractSequentialList`, `ArrayList`, `AttributeList`, `CopyOnWriteArrayList`, `LinkedList`, `RoleList`, `RoleUnresolvedList`, `Stack`, and `Vector`.



²If you implemented it as is shown in our examples

Which implementation is the best for you?

Some criteria (incomplete list):

- Thread Safety
- Access Method
- Performance
- Functionality

Read the documentation, which gives you important information like:

- `AbstractList`: skeletal implementation of random access list
- `AbstractSequentialList`: skeletal implementation of sequential access list
- `ArrayList` vs `Vector`: `Vector` is thread safe. Different resizing strategies
- `CopyOnWriteArrayList`: thread safe variant of `ArrayList`.
- `ArrayList` vs `LinkedList`: random vs sequential access

Example

Suppose, you have a `Collection <String> c`, which may be a `List`, a `Set`, or another kind of `Collection`.

```
Collection<String> c = new HashSet<>();
```

This idiom creates a new `ArrayList` (an implementation of the `List` interface), initially containing all the elements in `c`.

```
List<String> list = new ArrayList<>(c);
```

Symbiosis between Set and Map

A Map is an object that maps keys to values. A map cannot contain duplicate keys: Each key can map to at most one value. The keys of a Map are stored in a Set, which guarantees the uniqueness of the keys.

Java platform contains three general purpose implementations of the Map interface:

- `HashMap` which (doesn't retain insertion order),
- `LinkedHashMap` (iteration order == insertion order)
- `TreeMap` iteration order is sorted order by key (using a comparator or natural order.).

Their behavior and performance are precisely analogous to `HashSet`, `LinkedHashSet` and `TreeSet` which are used to store the keys.

The Comparator interface

The Comparator interface can be used to compare the objects of a class that doesn't implement the Comparable interface. Demo example SimpleCollection, see course website.

Comparator:

```
public class AreaComparator implements Comparator<GeometricObject> {
    /* returns -1 if area of o1 is smaller than area of o2
       returns 1 if area of o1 is greater than area of o2
       returns 0 in all other cases */
    @Override
    public int compare(GeometricObject go1, GeometricObject go2) {
        if (go1.getArea() < go2.getArea()) return -1;
        if (go1.getArea() > go2.getArea()) return 1;
        return 0;
    }
}
```

Example call:

```
Circle c = new Circle(10);
Rectangle r = new Rectangle(5,5);
AreaComparator ac = new AreaComparator();
if (ac.compare(r, c)<0) {System.out.println("smaller");}
```

The Comparable interface

In case you are designer of the class you could use the Comparable interface.

Comparable:

```
public class Rectangle implements GeometricObject, Comparable<GeometricObject> {  
  
    @Override  
    public int compareTo(GeometricObject go) {  
        // still to implement  
        if (getArea() < go.getArea()) return -1;  
        if (getArea() > go.getArea()) return 1;  
        return 0;  
    }  
}
```

Example call:

```
Rectangle r1 = new Rectangle(5,5);  
Rectangle r2 = new Rectangle(3,7);  
if (r1.compareTo(r2)<0) {System.out.println("smaller");}
```

What's the difference? Compare Comparable to Comparator!

Download SimpleCollection code, link is on the course website.

For more information see source code and unit tests.

- 1 Implement the PerimeterComparator which implements the Comparator interface.
- 2 Extend Circle in such a way that it implements the Comparable interface
- 3 Implement the static SimpleCollection.conditionalAddToCollection() method, first have a look at the unit tests.
- 4 Implement the static SimpleCollection.print() method, first have a look at the unit tests.
- 5 What's your favorite method of traversing a collection, solve 4. using a stream.

Links to more examples, book chapters

Example with java 8 aggregate functions.

See: <http://docs.oracle.com/javase/tutorial/collections/interfaces/map.html>

For more easy to understand collection and stream examples see:

<http://www.mkyong.com/java8/java-8-foreach-examples>

Book by Y. Daniel Lang.

Chapter 20, paragraphs 20.1-20.6 Lists, Stacks, Queues and Priority Queues

Questions and links

Not all understood?

Study

Java collection Tutorial and
Questions?

Questions or remarks?