Core Java 8 and Development Tools

Lesson 11: Collection

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Lesson Objectives

After completing this lesson, participants will be able to

- Understand collection framework
- Implement and use collection classes
- Iterate collections
- Create collection of user defined type

11.1: Collections Framework
Collections Framework

A Collection is a group of objects.

Collections framework provides a set of standard utility classes to manage collections.

Collections Framework consists of three parts:

- Core Interfaces
- Concrete Implementation
- Algorithms such as searching and sorting

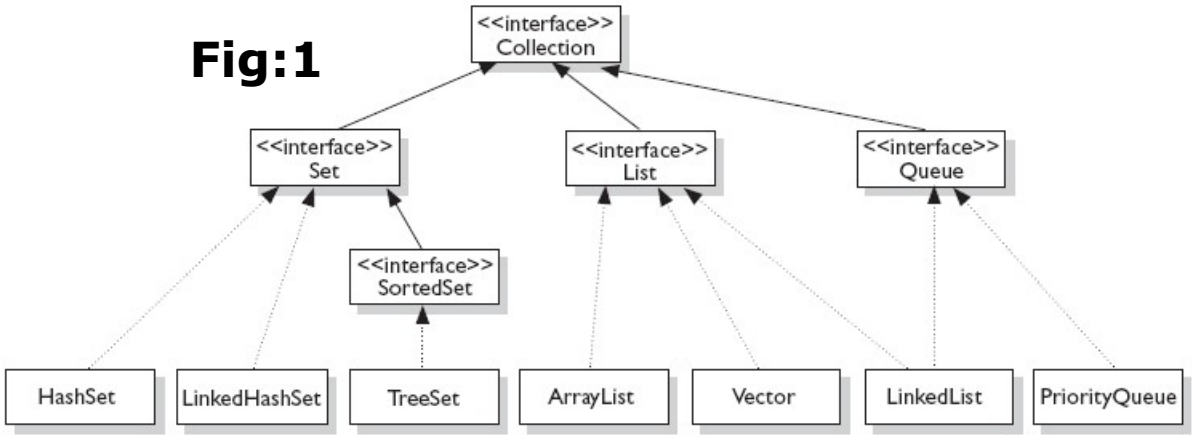
11.1: Collections Framework
Advantages of Collections

Collections provide the following advantages:

- Reduces programming effort
- Increases performance
- Provides interoperability between unrelated APIs
- Reduces the effort required to learn APIs
- Reduces the effort required to design and implement APIs
- Fosters Software reuse

11.1: Collections Framework
Concept of Interfaces and Implementation

Fig:1



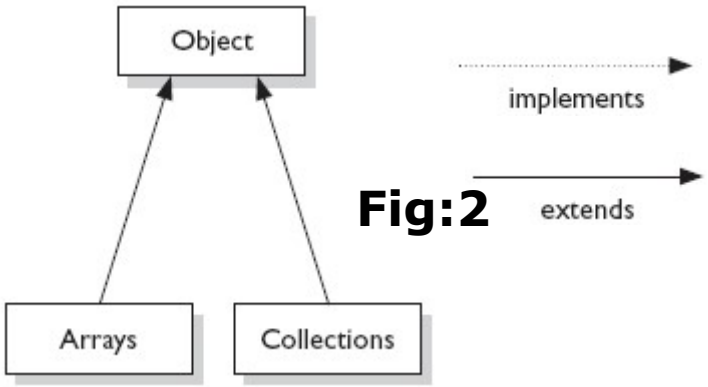
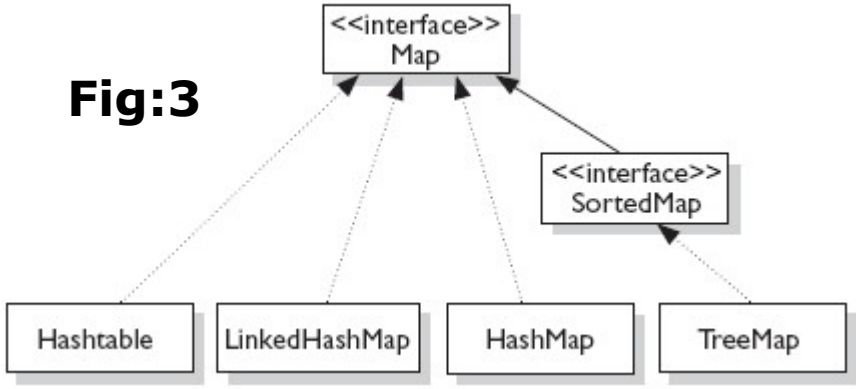


Fig:2

implements

extends

Fig:3



11.2: Collection Interfaces
Collection Interfaces

Let us discuss some of the collection interfaces:

Interfaces	Description
Collection	A basic interface that defines the operations that all the classes that maintain collections of objects typically implement.
Set	Extends the Collection interface for sets that maintain unique element.
SortedSet	Augments the Set interface or Sets that maintain their elements in sorted order.
List	Collections that require position-oriented operations should be created as lists. Duplicates are allowed.
Queue	Things arranged by the order in which they are to be processed.
Map	A basic interface that defines operations that classes that represent mapping of keys to values typically implement.
SortedMap	Extends the Map interface for maps that maintain their mappings in the key order.

11.2: Collection Interfaces
Collection Implementations

Collection Implementations:

		Implementations				
		Hash Table	**Resizable Array**	**Balanced Tree**	**Linked List**	**Hash Table + Linked List**
Interfaces	**Set**	HashSet		TreeSet		LinkedHashSet
	List		ArrayList		LinkedList	
	Map	HashMap		TreeMap		LinkedHashMap

11.2: Collection Interfaces
Collection Implementations

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11.2: Collection Interfaces
Collection Interface methods

Method	Description
`int size();`	Returns number of elements in collection.
`boolean isEmpty();`	Returns true if invoking collection is empty.
`boolean contains(Object element);`	Returns true if element is an element of invoking collection.
`boolean add(Object element);`	Adds element to invoking collection.
`boolean remove(Object element);`	Removes one instance of element from invoking collection
`Iterator iterator();`	Returns an iterator fro the invoking collection
`boolean containsAll(Collection c);`	Returns true if invoking collection contains all elements of *c*; false otherwise.
`boolean addAll(Collection c);`	Adds all elements of *c* to the invoking collection.
`boolean removeAll(Collection c);`	Removes all elements of *c* from the invoking collection
`boolean retainAll(Collection c);`	Removes all elements from the invoking collection except those in *c*.
`void clear();`	Removes all elements from the invoking collection
`Object[] toArray();`	Returns an array that contains all elements stored in the invoking collection
`Object[] toArray(Object a[]);`	Returns an array that contains only those collection elements whose type matches that of *a*.

11.3: AutoBoxing with Collections
AutoBoxing with Collections

Boxing conversion converts primitive values to objects of corresponding wrapper types.

```
int intVal = 11;
Integer iReference = new Integer(i); // prior to Java 5, explicit
Boxing
iReference = intVal;                 // In Java 5,Automatic
Boxing
```

Unboxing conversion converts objects of wrapper types to values of corresponding primitive types.

```
int intVal = iReference.intValue();    // prior to Java5, explicit
unboxing
intVal = iReference;                   // In Java 5, Automatic
Unboxing
```

11.3: Iterating Collection
Iterating through a collection

Iterator is an object that enables you to traverse through a collection.

It can be used to remove elements from the collection selectively, if desired.

```
public interface Iterator<E>
 {
 boolean hasNext();
 E next();
void remove();
 }
```

Iterable is an superinterface of Collection interface, allows to iterate the elements using foreach method

```
Collection.forEach(Consumer<? super T> action)
```

11.3: Iterating Collection
Enhanced for loop

Iterating over collections looks cluttered:

```
void printAll(Collection<Emp> employees) {
    for (Iterator<Emp> iterator = employees.iterator(); iterator.hasNext(); )
        System.out.println(iterator.next()); } }
```

Using enhanced for loop, we can do the same thing as:

```
void printAll(Collection<Emp> employees) {
    for (Emp empObj : employees) )
        System.out.println( empObj ); }}
```

- When you see the colon (:) read it as "in."
- The loop above reads as "for each emp 't' in collection 'e'."

11.3: Iterating Collection Demo :Concept of Iterators

Execute:

- MailList.java
- ItTest.java program

11.4: Implementing Classes
ArrayList Class

An ArrayList Class can grow dynamically.

It provides more powerful insertion and search mechanisms than arrays.

It gives faster Iteration and fast random access.

It uses Ordered Collection (by index), but not Sorted.

```
ArrayList<Integer> list = new ArrayList<Integer>();
list.add(0, new Integer(42));
int total = list.get(0).intValue();
```

11.4: Implementing Classes
Demo: Array List Class

Execute the ArrayListDemo.java program

11.4: Implementing Classes
HashSet Class

HashSet Class does not allow duplicates.

A HashSet is an unsorted, unordered Set.

It can be used when you want a collection with no duplicates and you do not care about the order when you iterate through it.

11.4: Implementing Classes
Demo: Hash Set Class

Execute the HashSetDemo.java program

11.4: Implementing Classes
TreeSet class

TreeSet does not allow duplicates.

It iterates in sorted order.

Sorted Collection:

- By default elements will be in ascending order.

Not synchronized:

- If more than one thread wants to access it at the same time, then it must be synchronized externally.

11.4: Implementing Classes
Demo: Tree Set class

Execute the Treeset.java program

11.5: Comparable and Comparator
Comparator Interface

The java.util.Comparator interface can be used to sort the elements of an Array or a list in the required way.

It gives you the capability to sort a given collection in any number of different ways.

Methods defined in Comparator Interface are as follows:

- int compare(Object o1, Object o2)
  - It returns true if the iteration has more elements.
- boolean equals(Object obj)
  - It checks whether an object equals the invoking comparator.

11.5: Comparable and Comparator
Comparable Interface

Java.util.Comparable interface imposes a total ordering on the objects of each class that implements it.

This ordering is referred to as the class's *natural ordering*, and the class's compareTo method is referred to as its *natural comparison method*.

Methods defined in Comparable Interface are as follows:

- public int compareTo(Object o)
- Compares this object with the specified object for order. Returns a negative integer, zero, or a positive integer as this object is less than, equal to, or greater than the specified object.

11.5: Comparable and Comparator
Comparable Interface Example

```
class Emp implements Comparable {
    int empID;
    String empName;
    double empSal;
     public Emp(String ename, double sal) { …  }
     public String toString() {  …  }

      public int compareTo(Object o) {
          if (this.empSal == ((Emp) o).empSal)    return 0;
            else if (this.empSal > ((Emp) o).empSal)   return 1;
               else   return -1;
    }}
```

11.5: Comparable and Comparator
Comparable Interface Example (ctnd…)

```
class Comparable Demo {
      public static void main(String[] args) {
         TreeSet tset = new TreeSet();
         tset.add(new Emp("harry", 40000.00));
         tset.add(new Emp("Mary", 20000.00));
         tset.add(new Emp("Peter", 50000.00));

         Iterator iterator = tset.iterator();
         while (iterator.hasNext()) {
            Object empObj = iterator.next();
            System.out.println(empObj + "\n");
         }
}}
```

Output:

```
Ename : Mary    Sal : 20000.0
Ename : harry   Sal : 40000.0
Ename : Peter   Sal : 50000.0
```

11.5: Comparable and Comparator
Demo : Concept of Comparator & Comparable Interface

Execute:

- ComparatorExample.java
- ComparableDemo.java

11.6: Map implementation
HashMap Class

HashMap uses the hashcode value of an object to determine how the object should be stored in the collection.

Hashcode is used again to help locate the object in the collection.

HashMap gives you an unsorted and unordered Map.

It allows one null key and multiple null values in a collection.

11.6: Map implementation
Demo: HashMap Class

Execute the HashMapDemo.java program

11.7: The Legacy Classes
Vector Class

The java.util.Vector class implements a growable array of Objects.

It is same as ArrayList. However, Vector methods are synchronized for thread safety.

New java.util.Vector is implemented from List Interface.

Creation of a Vector:

- Vector v1 = new Vector(); // allows old or new methods
- List v2 = new Vector(); // allows only the new (List) methods.

11.7: The Legacy Classes
Hashtable Class

It is a part of java.util package.

It implements a hashtable, which maps keys to values.

- Any non-null object can be used as a key or as a value.
- The Objects used as keys must implement the **hashcode** and the **equals method**.

Synchronized class

11.7: The Legacy Classes
Demo: Hash table Class

Execute the HashTableDemo.java program

Lab

Lab 7: Arrays and Collections

11.8: Common Best Practices on Collections
Best Practices

Let us discuss some of the best practices on Collections:

- Use for-each liberally.
- Presize collection objects.
- Note that Vector and HashTable is costly.
- Note that LinkedList is the worst performer.

11.8: Common Best Practices on Collections
Best Practices

- Choose the right Collection.
- Note that adding objects at the beginning of the collections is considerably slower than adding at the end.
- Encapsulate collections.
- Use thread safe collections when needed.

11.8: Common Best Practices on Collections Best Practices

Notes page

Summary

The various Collection classes and Interfaces

Generics

Best practices in Collections

Review Questions

Question 1: Consider the following code:

```
TreeSet map = new TreeSet();
    map.add("one");
    map.add("two");
    map.add("three");
    map.add("one");
    map.add("four");
    Iterator it = map.iterator();
    while (it.hasNext() )
        System.out.print( it.next() + " " );
```

- **Option 1:** Compilation fails
- **Option 2:** four three two one
- **Option 3:** one two three four
- **Option 4:** four one three two

Review Questions

Question 2: Which of the following statements are true for the given code?

```
public static void before() {
   Set set = new TreeSet();
   set.add("2");
   set.add(3);
   set.add("1");
   Iterator it = set.iterator();
     while (it.hasNext())
          System.out.print(it.next() + " ");
}
```

- **Option 1:** The before() method will print 1 2
- **Option 2:** The before() method will print 1 2 3
- **Option 3:** The before() method will not compile.
- **Option 4:** The before() method will throw an exception at runtime.