Collections Framework

java.util package

Introduction to Collections

- **A *collection***
  - is a container
  - is an object that groups multiple elements into a single unit
  - used to store, retrieve, manipulate, and communicate aggregate data.
- **They represent data items that form a natural group**
  - a poker hand (a collection of cards)
  - a mail folder (a collection of letters),
  - a telephone directory (a mapping of names to phone numbers)

What Is a Collections Framework?

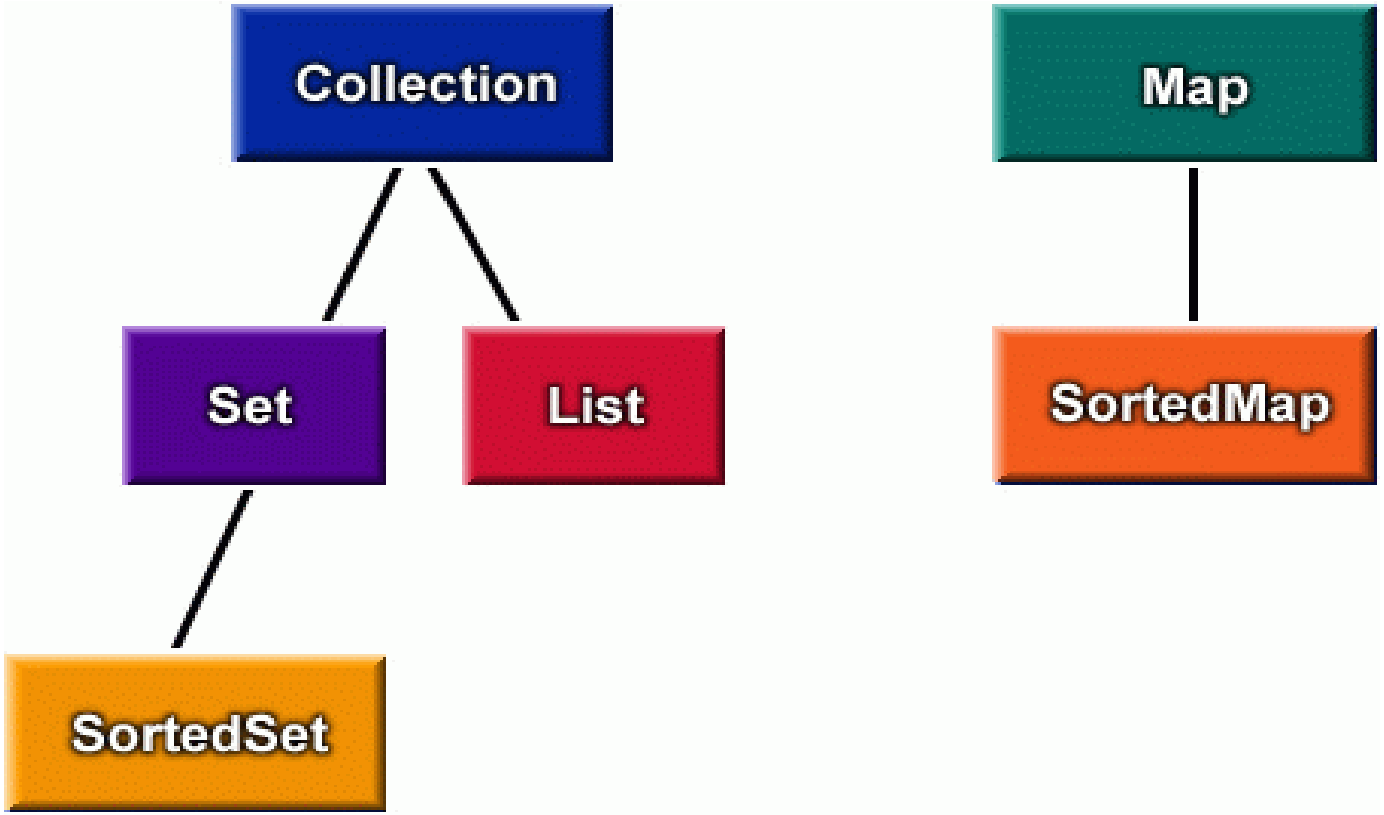
- **A *collections framework* is a unified architecture for representing and manipulating collections**
- **All collections frameworks contain**
  - **Interfaces**
    - These are abstract data types that represent collections
  - **Implementations**
    - These are the concrete implementations of the collection interfaces
    - they are reusable data structures
  - **Algorithms**
    - These are the methods that perform useful computations
    - The algorithms are said to be *polymorphic*

Benefits of the Java Collections Framework

- Reduces programming effort
- Increases program speed and quality
- It allows interoperability among unrelated APIs
- It reduces the effort to learn and use new APIs
- It reduces effort to design new APIs
- It fosters software reuse

core collection interfaces

- **Core collection interfaces are the foundation of the Java Collections Framework**



The Collection Interface

- **Collection — the root of the collection hierarchy**
- **A collection represents a group of objects known as its *elements***
- **Some types of collections allow duplicate elements, and others do not. Some are ordered and others are unordered.**
- **The Java platform doesn't provide any direct implementations of this interface but provides implementations of more specific subinterfaces, such as *Set* and *List.***

The Collection Interface

```
public interface Collection {
    // Basic operations
    int size();
    boolean isEmpty();
    boolean contains(Object element);
    boolean add(Object element);
    boolean remove(Object element);
     Iterator iterator();

    // Bulk operations
    boolean containsAll(Collection c);
    boolean addAll(Collection c); //optional
    boolean removeAll(Collection c);       //optional
    boolean retainAll(Collection c);       //optional
    void clear();                          //optional

    // Array operations
    Object[]  toArray();
     Object[]  toArray(Object[] a);
}
```

Methods of Collection Framework

Method Summary	
boolean	**add**(Object o)
boolean	**addAll**(Collection c)
void	**clear**()
boolean	**contains**(Object o)
boolean	**containsAll**(Collection c)
boolean	**equals**(Object o)
int	**hashCode**()
boolean	**isEmpty**()
Iterator	**iterator**()
boolean	**remove**(Object o)
boolean	**removeAll**(Collection c)
boolean	**retainAll**(Collection c)
int	**size**()
Object[]	**toArray**()
Object[]	**toArray**(Object[] a)

Traversing Collections

- **To traverse the collection we need to use Iterators**
  - An Iterator is an object that enables you to traverse through a collection and to remove elements from the collection selectively, if desired.
- **You get an Iterator for a collection by calling its `iterator` method.**
- **The following is the Iterator interface.**

```
public interface Iterator {
boolean hasNext();
Object next();
void remove(); //optional
}
```

The Set Interface

- **A Set is a Collection that cannot contain duplicate elements.**
  - It models the mathematical set abstraction
- **The Set interface contains *only* methods inherited from Collection**
- **Adds the restriction that duplicate elements are prohibited**

The Set interface

```
public interface Set extends Collection {
    // Basic operations
    int size();
    boolean isEmpty();
    boolean contains(Object element);
    boolean add(Object element);         //optional
    boolean remove(Object element); //optional
    Iterator iterator();

    // Bulk operations
    boolean containsAll(Collection c);
    boolean addAll(Collection> c); //optional
    boolean removeAll(Collection c);        //optional
    boolean retainAll(Collection c);        //optional
    void clear();                           //optional

    // Array Operations
    Object[] toArray();
    Object[] toArray(Object[] a);
}
```

Implementations of Set interface

- **The Java platform contains three general-purpose Set implementations**
- **HashSet**
  - which stores its elements in a hash table, is the best-performing implementation; however it makes no guarantees concerning the order of iteration
- **TreeSet**
  - which stores its elements in a red-black tree, orders its elements based on their values; it is substantially slower than HashSet
- **LinkedHashSet**
  - which is implemented as a hash table with a linked list running through it
  - orders its elements based on the order in which they were inserted into the set (insertion-order)

HashSet : example

```
import java.util.*;

public class FindDups {
    public static void main(String[] args) {
        Set<String> s = new HashSet<String>();
        for (String a : args)
            if (!s.add(a))
                System.out.println("Duplicate detected: " + a);

        System.out.println(s.size() + " distinct words: " + s);
    }
}
```

Now run the program.
java FindDups i came i saw i left

The following output is produced.
Duplicate detected: i
Duplicate detected: i
4 distinct words: [i, left, saw, came]

The *List* interface

- **A List is an ordered Collection (sometimes called a *sequence*).**
- **Lists may contain duplicate elements.**
- **In addition to the operations inherited from Collection, the List interface includes operations for the following:**
  - **Positional access**
    - manipulates elements based on their numerical position in the list
  - **Search**
    - searches for a specified object in the list and returns its numerical position
  - **Iteration**
    - extends Iterator semantics to take advantage of the list's sequential nature
  - **Range-view**
    - performs arbitrary *range operations* on the list.

The List interface

```
public interface List extends Collection {
    // Positional access
    Object get(int index);
    Object set(int index, Object element);    //optional
    boolean add(E element);         //optional
    void add(int index, Object element); //optional
    Object remove(int index);           //optional
    boolean addAll(int index,Collection c); //optional

    // Search
    int indexOf(Object o);
    int lastIndexOf(Object o);

    // Iteration
    ListIterator listIterator();
    ListIterator listIterator(int index);

    // Range-view
    List subList(int from, int to);
}
```

List implementations

- **The Java platform contains two general-purpose List implementations.**
- **ArrayList**
  - usually the better-performing implementation
- **LinkedList**
  - offers better performance under certain circumstances.

- **Also, Vector has been reengineered to implement List.**

LinkedList :Example

```
import java.util.*;
 class LinkedListDemo {
 public static void main(String args[]) {
 LinkedList list = new LinkedList();
 list.add(new Integer(1));
 list.add(new Integer(2));
 list.add(new Integer(3));
 list.add(new Integer(1));
 System.out.println(list+", size = "+list.size());
 list.addFirst(new Integer(0));
 list.addLast(new Integer(4));
 System.out.println(list);
 System.out.println(list.getFirst() + ", " + list.getLast());
```

LinkedList :Example

```
//continuation...
 System.out.println(list.get(2)+", "+list.get(3));
 list.removeFirst();
 list.removeLast();
 System.out.println(list);
 list.remove(new Integer(1));
 System.out.println(list);
 list.remove(2);
 System.out.println(list);
 list.set(1, "one");
 System.out.println(list);
 }
}
```

ArrayList : Example

- Definition:
  - **Resizable version an ordinary array**
  - **Implements the *List* interface**

```
import java.util.*;
class ArrayListDemo {
public static void main(String args[]) {
ArrayList al = new ArrayList(2);
System.out.println(al+", size = "+al.size());
al.add("R");
//continued...
```

ArrayList : Example

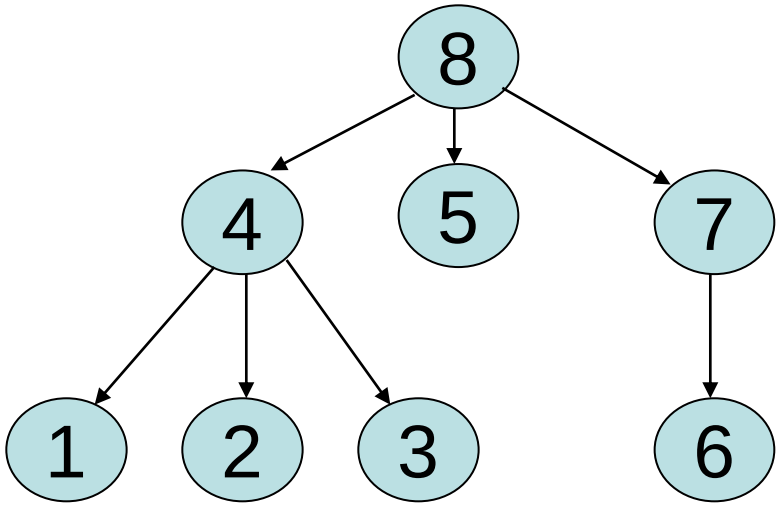
```
    al.add("U");
   al.add("O");
   System.out.println(al+", size = "+al.size());
   al.remove("U");
   System.out.println(al+", size = "+al.size());

   ListIterator li = al.listIterator();
     while (li.hasNext())
    System.out.println(li.next());
    Object a[] = al.toArray();
            for (int i=0; i<a.length; i++)
           System.out.println(a[i]);
     }
}
```

The SortedSet interface

- **A SortedSet is a Set that maintains its elements in ascending order, sorted according to the elements' natural ordering**
- **In addition to the normal Set operations, the SortedSet interface provides operations for the following:**
  - Range view
    - allows arbitrary range operations on the sorted set
  - Endpoints
    - returns the first or last element in the sorted set
  - Comparator access
    - returns the Comparator, if any, used to sort the set

TreeSet

- Definition:
  - Implementation of the *Set* interface that uses a tree
  - Tree
  - Ensures that the sorted set will be arranged in ascending order
- Tree representation



TreeSet : Example

```
import java.util.*;
class TSDemo{
public static void main( String[] args){
TreeSet ts = new TreeSet();
ts.add("Shantanu");
ts.add("Chandramouli");
ts.add("Arun");//new Integer(5));
ts.add("Pavan");//new Double(6.6));
ts.add("Sowjanya");
System.out.println(ts);

Iterator itr = hs.iterator();
    while(itr.hasNext()){
            System.out.println(itr.next());
    }
  }
};
```

The Map Interface

- **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.
- **It models the mathematical *function* abstraction**

key (object)	value (object)
Andhra Pradesh →	Hyderabad
Madhya Pradesh →	Bhopal
West Bengal →	Kolkata

The Map Interface

```
public interface Map {
    // Basic Operations
    Object put(Object key, Object value);
    Object get(Object key);
    Object remove(Object key);
    boolean containsKey(Object key);
    boolean containsValue(Object value);
    int size();
    boolean isEmpty();

    // Bulk Operations
    void putAll(Map t);
    void clear();

    // Collection Views
    public Set keySet();
    public Collection values();
    public Set entrySet();

    // Interface for entrySet elements
    public interface Entry {
        Object getKey();
        Object getValue();
        Object setValue(Object value);
    }
}
```

Implementations of Map

- **HashMap**
  - which stores its entries in a hash table, is the best-performing implementation.
- **Hashtable has been retrofitted to implement Map**
- **Other implementations**
  - Attributes, AuthProvider, ConcurrentHashMap, EnumMap, IdentityHashMap, LinkedHashMap, PrinterStateReasons, Properties, Provider, RenderingHints, TabularDataSupport, TreeMap, UIDefaults, WeakHashMap

HashTable:example

```
import java.util.*;

class HashTableDemo2
{
	public static void main(String[] args)
	{
	Hashtable ht = new Hashtable();
	ht.put("ap", "hyderabad");
	ht.put("kerala","tiruvananthapuram");
	ht.put("tamilnadu", "chennai");
	ht.put("Jaharkhand","Ranchi");

	System.out.println(ht);

	Set s=ht.keySet();
	Iterator i= s.iterator();
	while (i.hasNext()){
		Object o = i.next();
	String s1= (String)o;
	System.out.println("The cap. of "+s1+" is "+ht.get(s1));
	}
}
};
```

HashMap :Example

```
import java.util.*;

class HashMapDemo
{
    public static void main(String[] args)
    {
        HashMap hm = new HashMap();
        //TreeMap hm = new TreeMap();
        hm.put("shantanu", new Double(5000));
        hm.put("Sajid", new Double(3000.50));
        hm.put("Obul Reddy", new Double(500.90));
        hm.put("Manjula", new Double(4000.50));
        hm.put("Rajender",new Double(400.86));

//continued…
```

HashMap : Example

```
Set s = hm.entrySet();
        Iterator itr = s.iterator();
        while (itr.hasNext())
        {
                Map.Entry m =(Map.Entry)itr.next();
                System.out.print( m.getKey()+" : ");
                System.out.println( m.getValue());

        }

        double balance = ((Double)hm.get("shantanu")).doubleValue();
        hm.put("shantanu",new Double(balance+3000));
        System.out.print("shantanu's new Balance is..");
        System.out.println(hm.get("shantanu"));
                }
}
```

SortedMap interface

- **A SortedMap is a Map that maintains its entries in ascending order**
  - sorted according to the keys' *natural order*, or according to a Comparator provided at SortedMap creation time
- **Additional methods of SortedMap**
  - Range-view:
    - Performs arbitrary *range operations* on the sorted map.
  - Endpoints:
    - Returns the first or last key in the sorted map.
  - Comparator access:
    - Returns the Comparator used to sort the map (if any)

SortedMap interface

```
public interface SortedMap extends Map {
    Comparator comparator();

    SortedMap subMap(Object fromKey, Object toKey);
    SortedMap headMap(Object toKey);
    SortedMap tailMap(Object fromKey);

    Object firstKey();
    Object lastKey();
}
```

Implementations of SortedMap

- **TreeMap**
  - Red-Black tree based implementation of the SortedMap interface.
  - This class guarantees that the map will be in ascending key order, sorted according to the *natural order* for the key's class
  - or by the comparator provided at creation time, depending on which constructor is used.
- **This implementation is not synchronized**
  - If multiple threads access a map concurrently, and at least one of the threads modifies the map structurally, it *must* be synchronized externally.

TreeMap :Example

```
import java.util.*;

class TreeMapDemo
{
    public static void main(String[] args)
    {
        TreeMap hm = new TreeMap();
        hm.put("shantanu", new Double(5000));
        hm.put("Sajid", new Double(3000.50));
        hm.put("Obul Reddy", new Double(500.90));
        hm.put("Manjula", new Double(4000.50));
        hm.put("Rajender",new Double(400.86));

//continued…
```

TreeMap : Example

```
Set s = hm.entrySet();
        Iterator itr = s.iterator();
        while (itr.hasNext())
        {
                Map.Entry m =(Map.Entry)itr.next();
                System.out.print( m.getKey()+" : ");
                System.out.println( m.getValue());

        }

        double balance = ((Double)hm.get("shantanu")).doubleValue();
        hm.put("shantanu",new Double(balance+3000));
        System.out.print("shantanu's new Balance is..");
        System.out.println(hm.get("shantanu"));
                }
}
```

Thank You