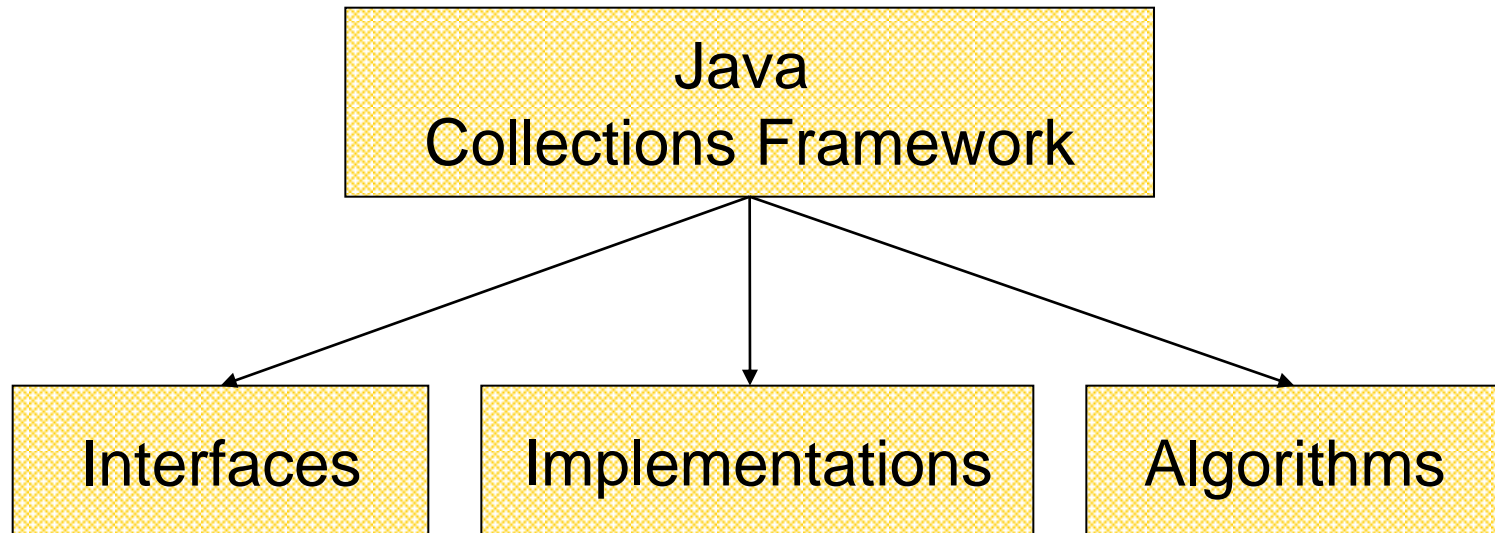


תוכנה 1

תרגול 7 – מבני נתונים גנריים
רובי בויס ומתי שמרת

Java Collections Framework

- **Collection:** a group of elements
- Interface Based Design:



Online Resources

- Java 6 API Specification:

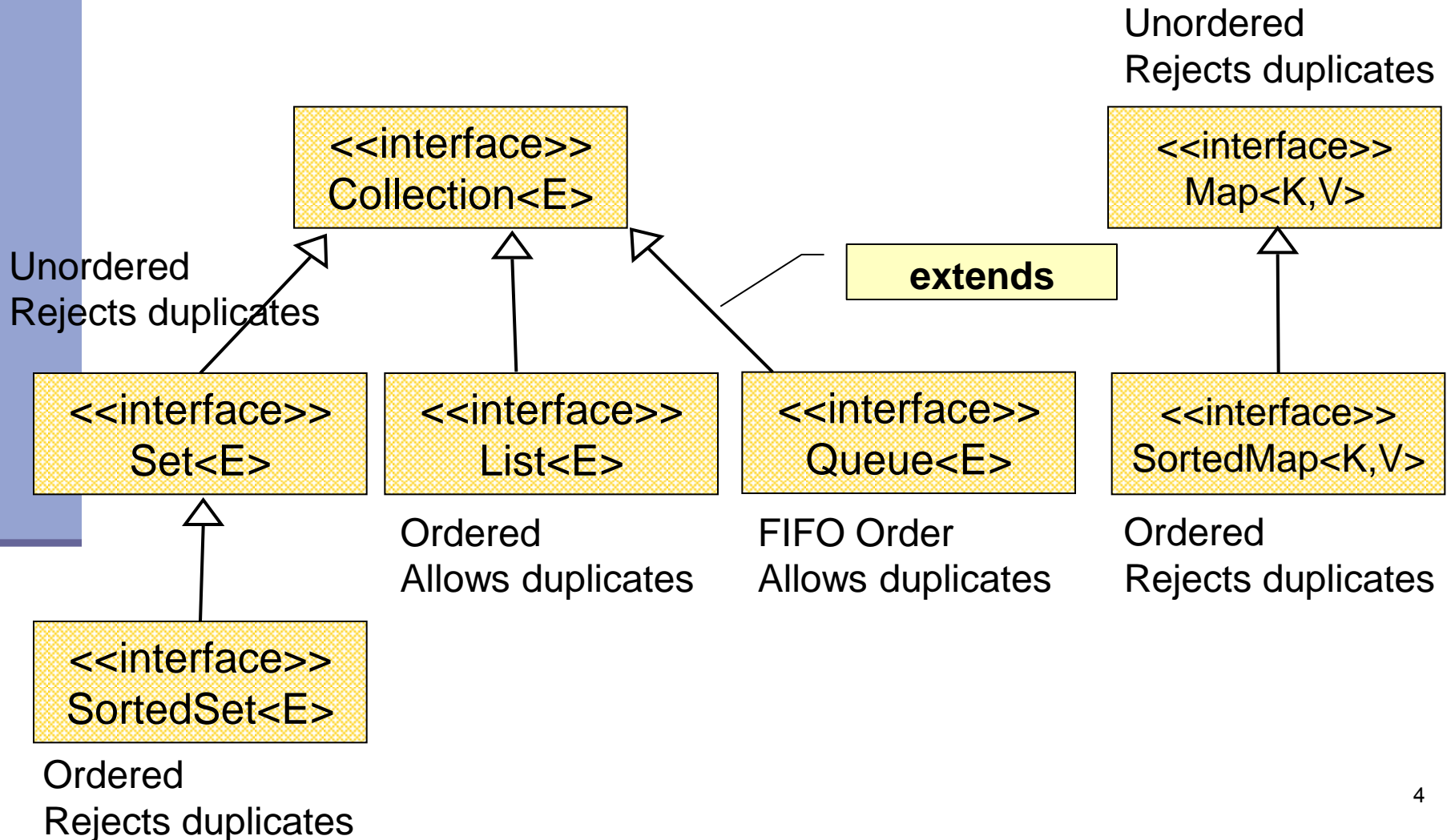
 - <http://java.sun.com/javase/6/docs/api/>

 - The Collections framework in [java.util](#)

- Sun Tutorial:

 - <http://java.sun.com/docs/books/tutorial/collections/>

Collection Interfaces



A Simple Example

```
Collection<String> stringCollection = ...  
Collection<Integer> integerCollection = ...
```

```
stringCollection.add("Hello");  
integerCollection.add(5);  
integerCollection.add(new Integer(6));
```

```
stringCollection.add(7);  
integerCollection.add("world");  
stringCollection = integerCollection;
```

A Simple Example

```
Collection<String> stringCollection = ...
```

```
Collection<Integer> integerCollection = ...
```

```
stringCollection
```

```
integerCollection
```

```
integerCollection
```

- מצביעים ל Collection של מחרוזות ושל מספרים
- Collection אינו מחזיק טיפוסים פרימיטיביים, לכן נשתמש ב Float ,Double ,Integer וכדומה
- נראה בהמשך אילו מחלקות מממשות מנשק זה

```
stringCollection.add(7);
```

```
integerCollection.add("world");
```

```
stringCollection = integerCollection;
```

A Simple Example

```
Collection<String> stringCollection = ...  
Collection<Integer> integerCollection = ...
```

```
stringCollection.add("Hello");
```

```
integerCollection.add(5);
```

```
integerCollection.add(new Integer(6));
```

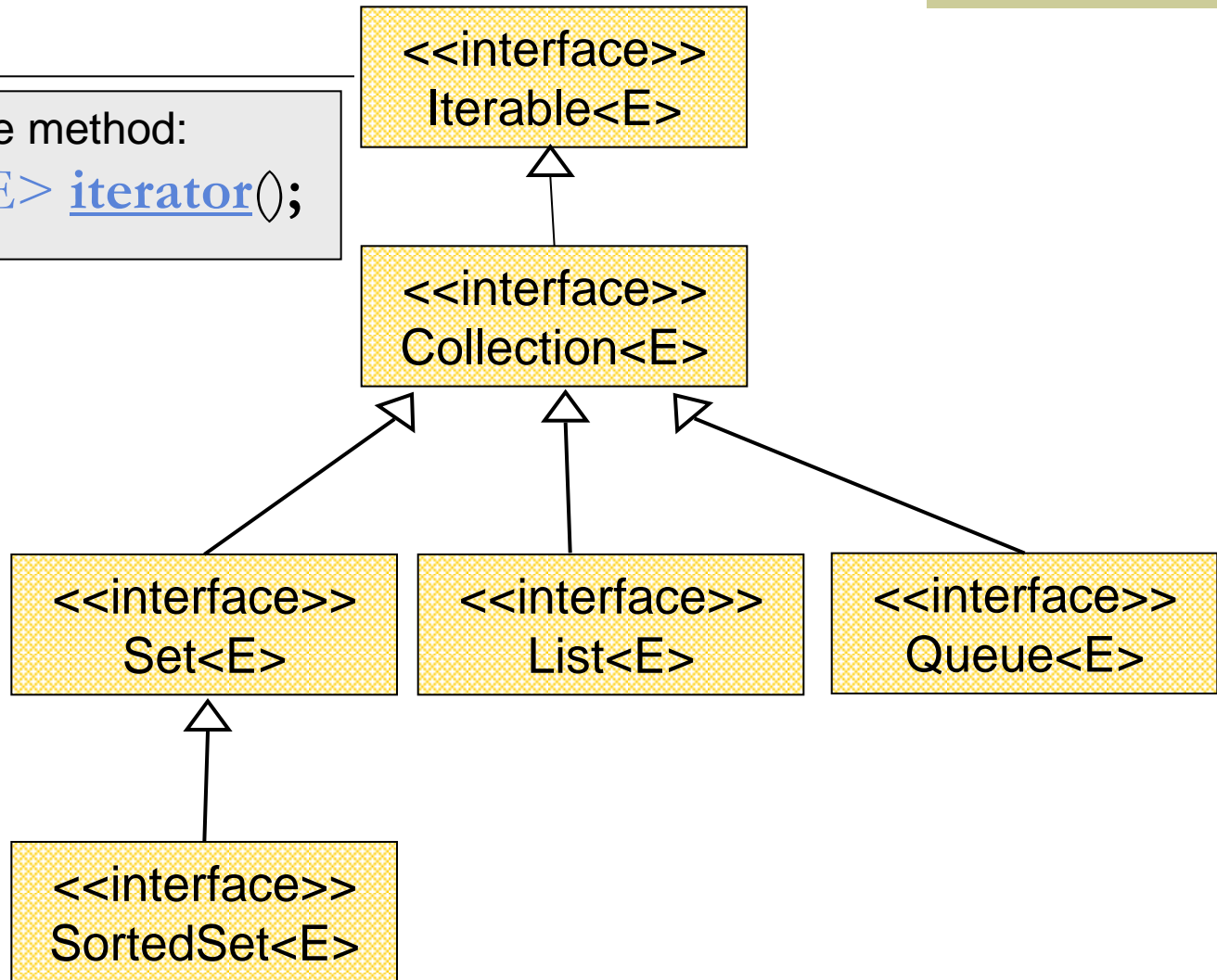
```
stringCollection.add(7);
```

```
integerCollection.add("world");
```

```
stringCollection = integerCollection;
```

Collection extends Iterable

has only one method:
`Iterator<E> iterator();`



The Iterator Interface

- Provide a way to access the elements of a collection sequentially without exposing the underlying representation
- Methods:
 - `hasNext()` - Returns true if there are more elements
 - `next()` - Returns the next element
 - `remove()` - Removes the last element returned by the iterator (optional operation)

Iterating over a Collection

■ Explicitly using an Iterator

```
for (Iterator<String> iter = stringCollection.iterator();  
     iter.hasNext(); ) {  
    System.out.println(iter.next());  
}
```

■ Using foreach syntax

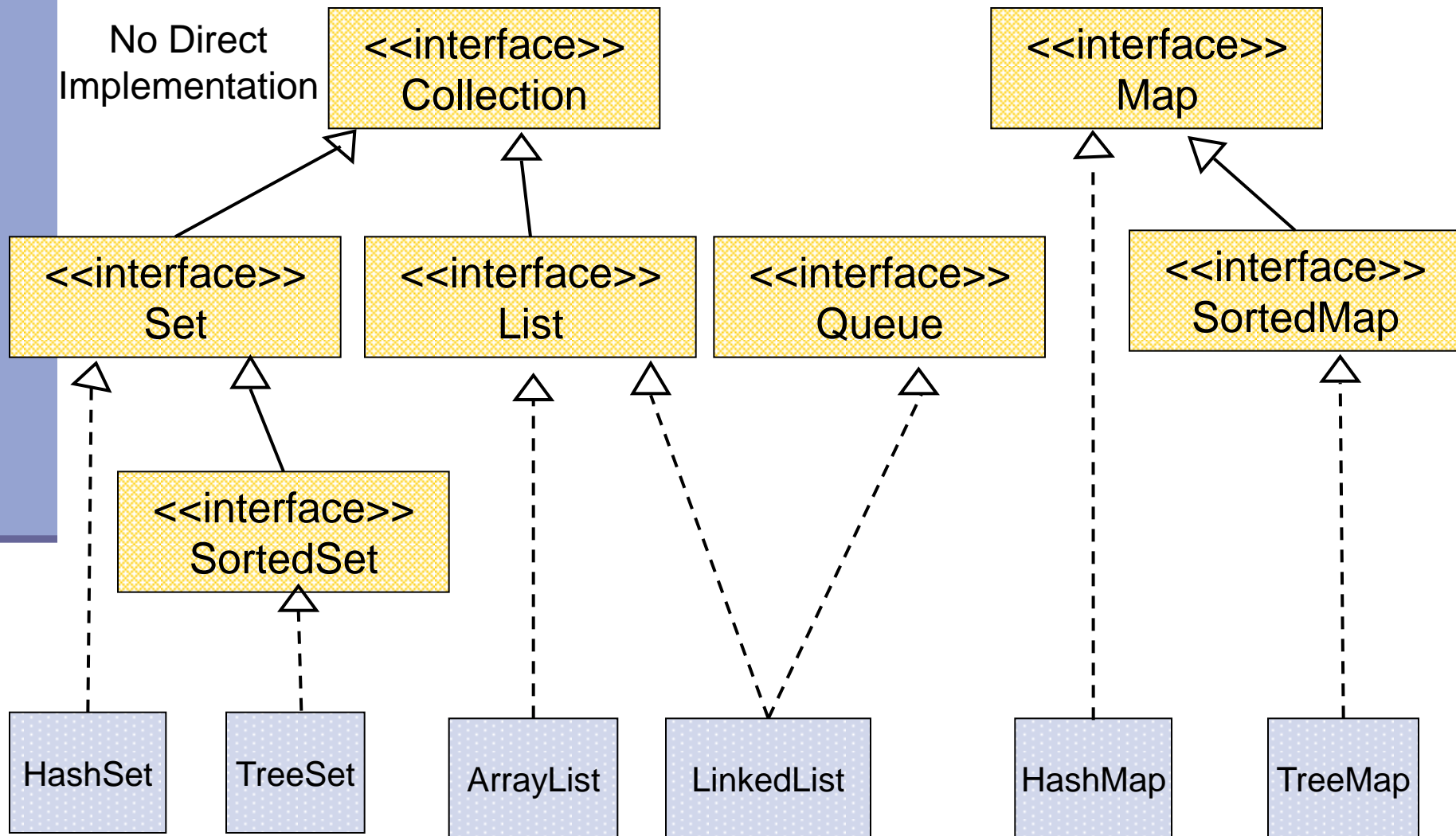
```
for (String str : stringCollection) {  
    System.out.println(str);  
}
```

Collection Implementations

- Class Name Convention: <Data structure> <Interface>

General Purpose Implementations		Data Structures			
		Hash Table	Resizable Array	Balanced Tree	Linked List
Interfaces	Set	HashSet		TreeSet (SortedSet)	
	Queue		ArrayDeque		LinkedList
	List		ArrayList		LinkedList
	Map	HashMap		TreeMap (SortedMap)	

General Purpose Implementations



Interface

List Example

```
List<Integer> list = new ArrayList<Integer>();  
list.add(3);  
list.add(1);  
list.add(new Integer(1));  
list.add(new Integer(6));  
list.remove(list.size()-1);  
System.out.println(list);
```

Implementation

List holds
Integer
references
(auto-boxing)

List allows
duplicates

Invokes
List.toString(
)

remove() can get
index or *reference*
as argument

Output:
[3, 1, 1]

Insertion
order is kept

Set Example

```
Set<Integer> set = new HashSet<Integer> ();  
set.add(3);  
set.add(1);  
set.add(new Integer(1));  
set.add(new Integer(6));  
set.remove(6);  
System.out.println(set);
```

A set does not allow duplicates. It **does not** contain:

- two references to the same object
- two references to null
- references to two objects a and b such that a.equals(b)

remove() can get only *reference* as argument

Output: [1, 3] or [3, 1]

Insertion order is not guaranteed

Queue Example

```
Queue<Integer> queue = new LinkedList<Integer> ();  
queue.add(3);  
queue.add(1);  
queue.add(new Integer(1));  
queue.add(new Integer(6));  
queue.remove();  
System.out.println(queue);
```

Elements are added
at the end of the
queue

remove() may
have no argument –
head is removed

Output: [1, 1, 6]

FIFO order

Map Example

```
Map<String,String> map = new HashMap<String,String>();  
map.put("Dan", "03-9516743");  
map.put("Rita", "09-5076452");  
map.put("Leo", "08-5530098");  
map.put("Rita", "06-8201124");  
System.out.println(map);
```

No duplicates

Unordered

Output:

```
{Leo=08-5530098, Dan=03-9516743, Rita=06-8201124}
```

Keys (names)	Values (phone numbers)
Dan	03-9516743
Rita	06-8201124
Leo	08-5530098

SortedMap Example

```
SortedMap <String,String>map = new TreeMap<String,String> ();  
map.put("Dan", "03-9516743");  
map.put("Rita", "09-5076452");  
map.put("Leo", "08-5530098");  
map.put("Rita", "06-8201124");  
System.out.println(map);
```

lexicographic order

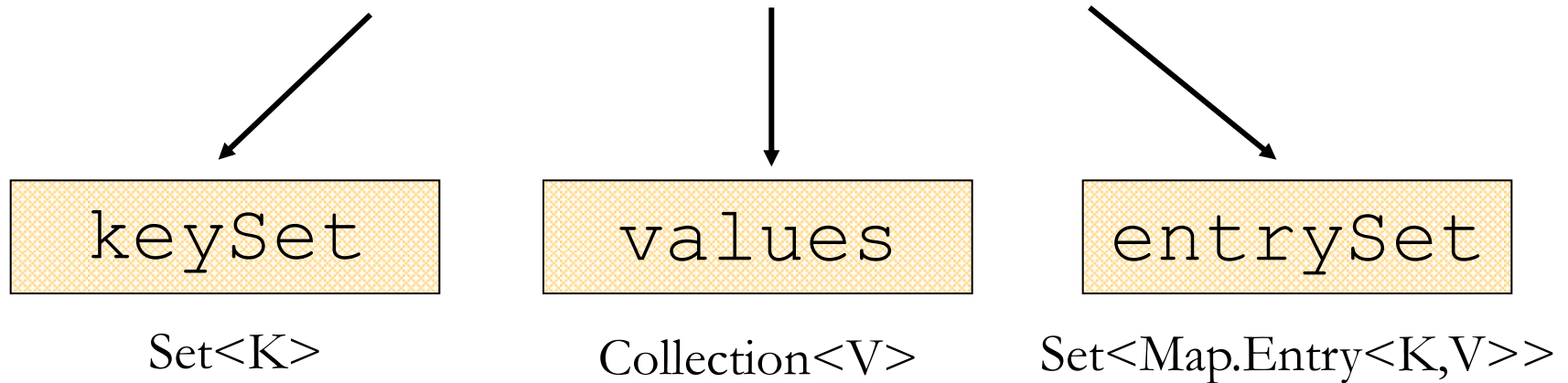
Output:

```
{Dan=03-9516743, Leo=08-5530098, Rita=06-8201124}
```

Keys (names)	Values (phone numbers)
Dan	03-9516743
Rita	06-8201124
Leo	08-5530098

Map Collection Views

Three views of a `Map<K, V>` as a collection



The Set of key-value pairs
(implement `Map.Entry`)

Iterating Over the Keys of a Map

```
Map<String,String> map = new HashMap<String,String> ();
map.put("Dan", "03-9516743");
map.put("Rita", "09-5076452");
map.put("Leo", "08-5530098");
map.put("Rita", "06-8201124");

for (Iterator<String> iter= map.keySet().iterator(); iter.hasNext(); ) {
    System.out.println(iter.next());
}
```

Output:

- Leo
- Dan
- Rita

Iterating Over the Keys of a Map

```
Map<String,String> map = new HashMap<String,String> ();
map.put("Dan", "03-9516743");
map.put("Rita", "09-5076452");
map.put("Leo", "08-5530098");
map.put("Rita", "06-8201124");

for (String key : map.keySet()) {
    System.out.println(key);
}
```

Output:

- Leo
- Dan
- Rita

Iterating Over the Key-Value Pairs of a Map

```
Map<String,String> map = new HashMap<String,String>();
map.put("Dan", "03-9516743");
map.put("Rita", "09-5076452");
map.put("Leo", "08-5530098");
map.put("Rita", "06-8201124");

for (Iterator<Map.Entry<String,String>> iter= map.entrySet().iterator();
     iter.hasNext();) {
    Map.Entry<String,String> entry = iter.next();
    System.out.println(entry.getKey() + ": " + entry.getValue());
}
```

Output: Leo: 08-5530098
 Dan: 03-9516743
 Rita: 06-8201124

Iterating Over the Key-Value Pairs of a Map

```
Map<String,String> map = new HashMap<String,String> ();
map.put("Dan", "03-9516743");
map.put("Rita", "09-5076452");
map.put("Leo", "08-5530098");
map.put("Rita", "06-8201124");

for (Map.Entry<String,String> entry: map.entrySet()) {
    System.out.println(entry.getKey() + ": " + entry.getValue());
}
```

Output:

```
Leo: 08-5530098
Dan: 03-9516743
Rita: 06-8201124
```

Collection Algorithms

- Defined in the Collections class
- Main algorithms:
 - sort
 - binarySearch
 - reverse
 - shuffle
 - min
 - max

Sorting

```
import java.util.*;
```

```
public class Sort {  
    public static void main(String args[]) {  
        List<String> list = Arrays.asList(args);  
        Collections.sort(list);  
        System.out.println(list);  
    }  
}
```

import the package of
List, Collections
and Arrays

returns a List-view of
its array argument.

Arguments: A C D B

Output: [A, B, C, D]

lexicographic
order

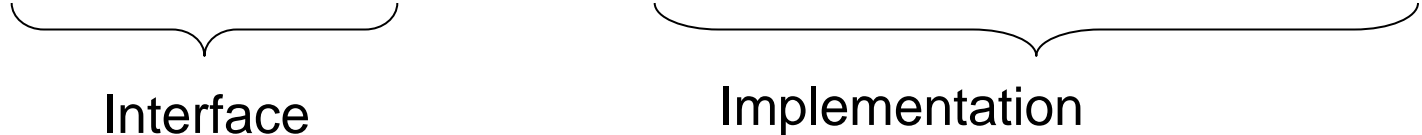
Sorting (cont.)

- Sort a List l by `Collections.sort(l);`
- If the list consists of `String` objects it will be sorted in lexicographic order. Why?
- `String` implements `Comparable<String>`:

```
public interface Comparable<T> {  
    public int compareTo(T o);  
}
```
- Error when sorting a list whose elements
 - do not implement `Comparable` or
 - are not *mutually comparable*.
- User defined comparator
 - `Collections.sort(List, Comparator);`

Best Practice <with generics>

- Specify an element type only when a collection is instantiated:

- `Set<String> s = new HashSet<String>();`


Works, but...

- `public void foo(HashSet<String> s) {...}`
- `public void foo(Set<String> s) {...}`
- `s.add()` invokes `HashSet.add()`

Better!

polymorphism