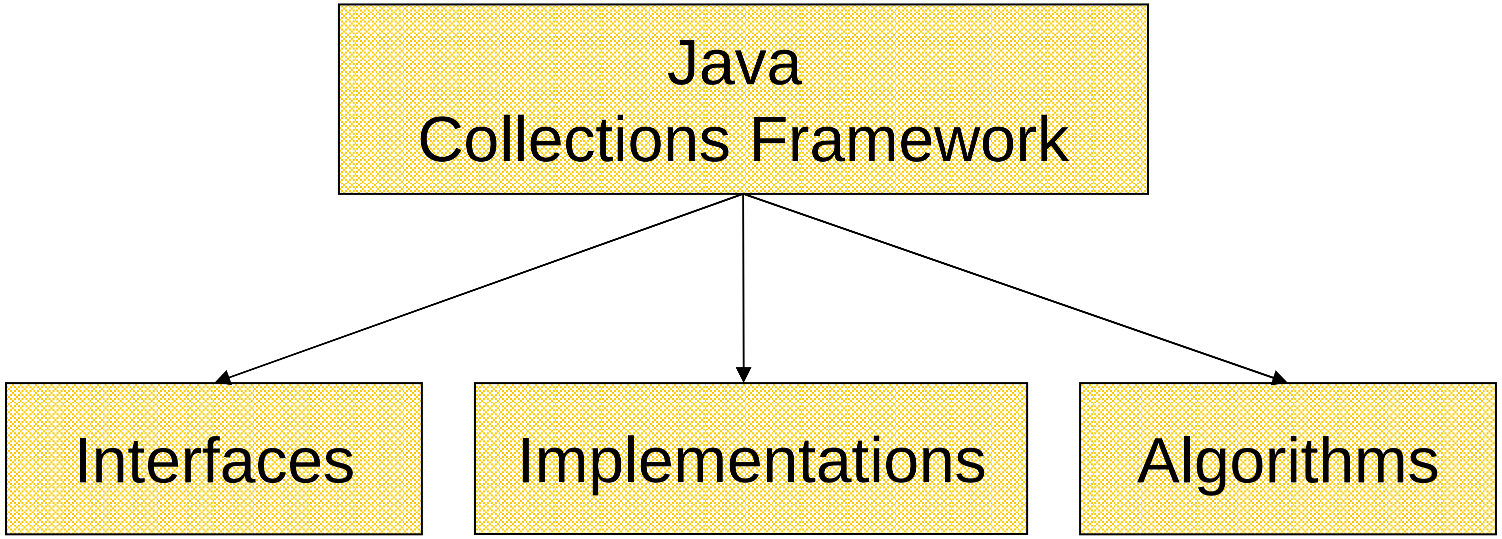
Software 1 with Java

Recitation No. 6
(Collections)

Java Collections Framework

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



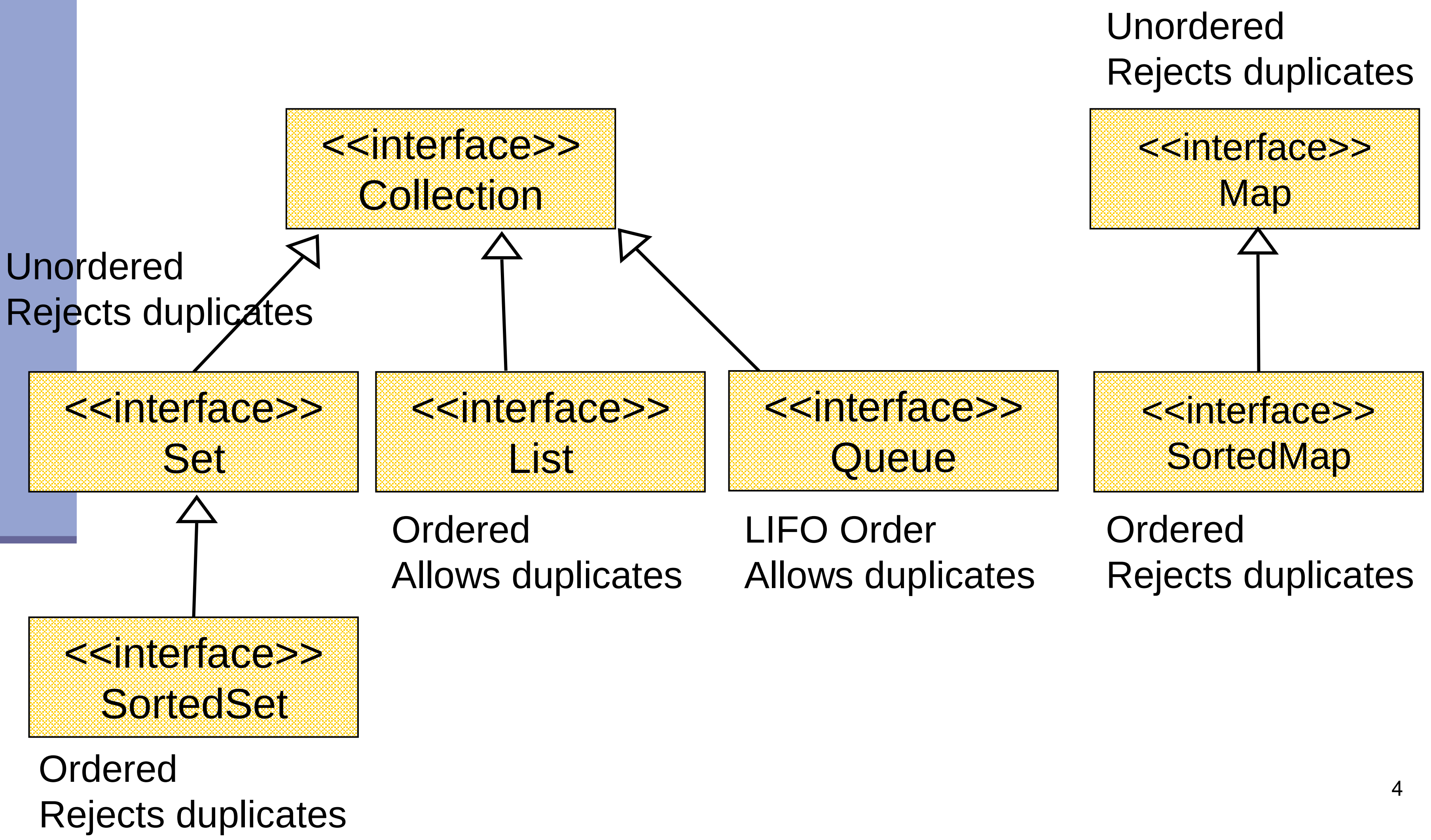
Online Resources

- Java 5 API Specification:

  http://java.sun.com/j2se/1.5.0/docs/api/index.html
- Sun Tutorial:

  http://java.sun.com/docs/books/tutorial/collections/

Collection Interfaces

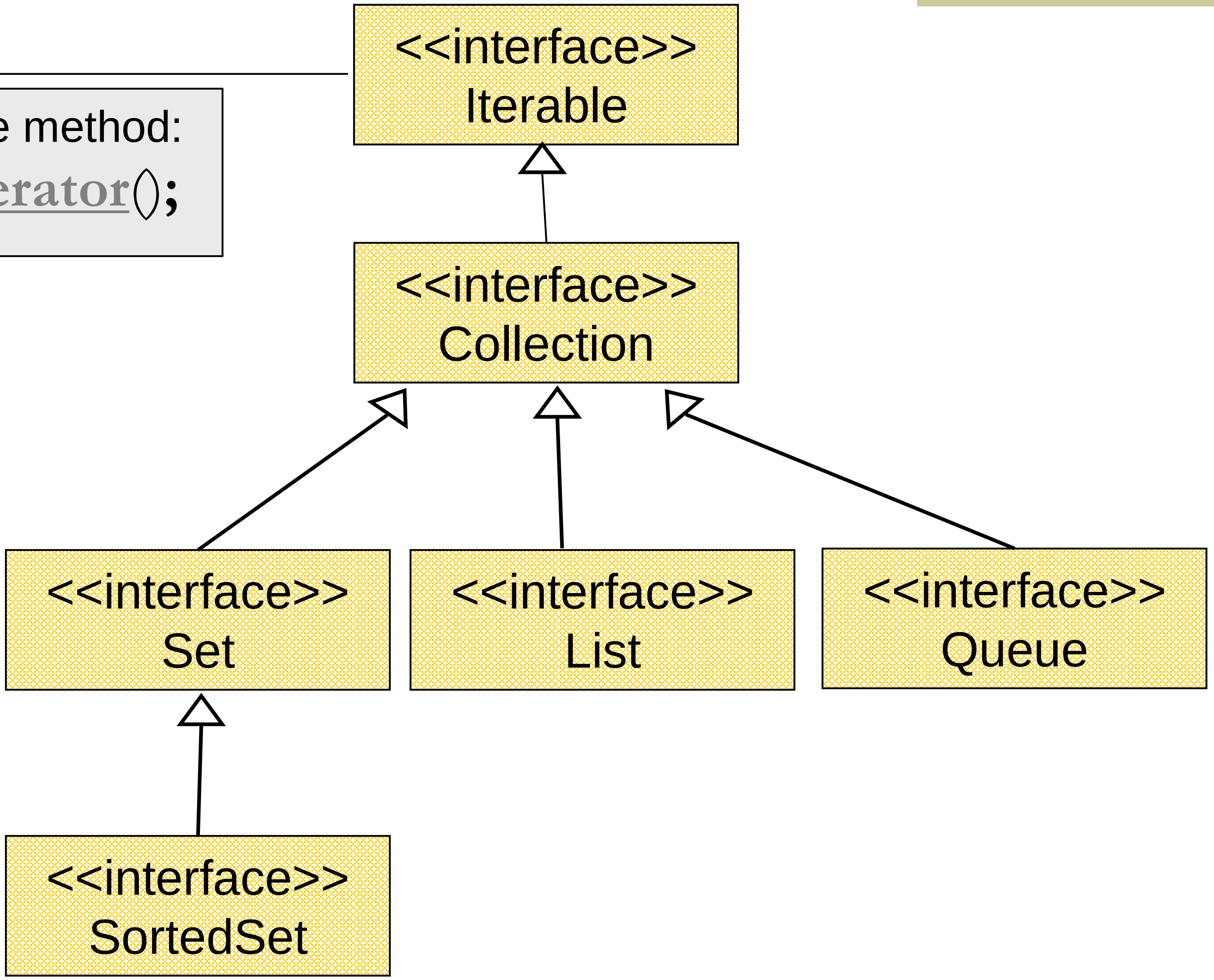


The `Collection` Interface

- Holds any `Object` references
  - Not type safe
  - Use casting
- Doesn’t hold primitives
  - Use wrapper classes
- Since Java5 collections are type-safe
  - Will be discussed later in the course

`Collection` extends `Iterable`

has only one method:
Iterator **iterator**();



The Iterator Interface

- Provide a way to access the elements of a collection sequentially without exposing its 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)

Command and Query

Iterating over a `Collection`

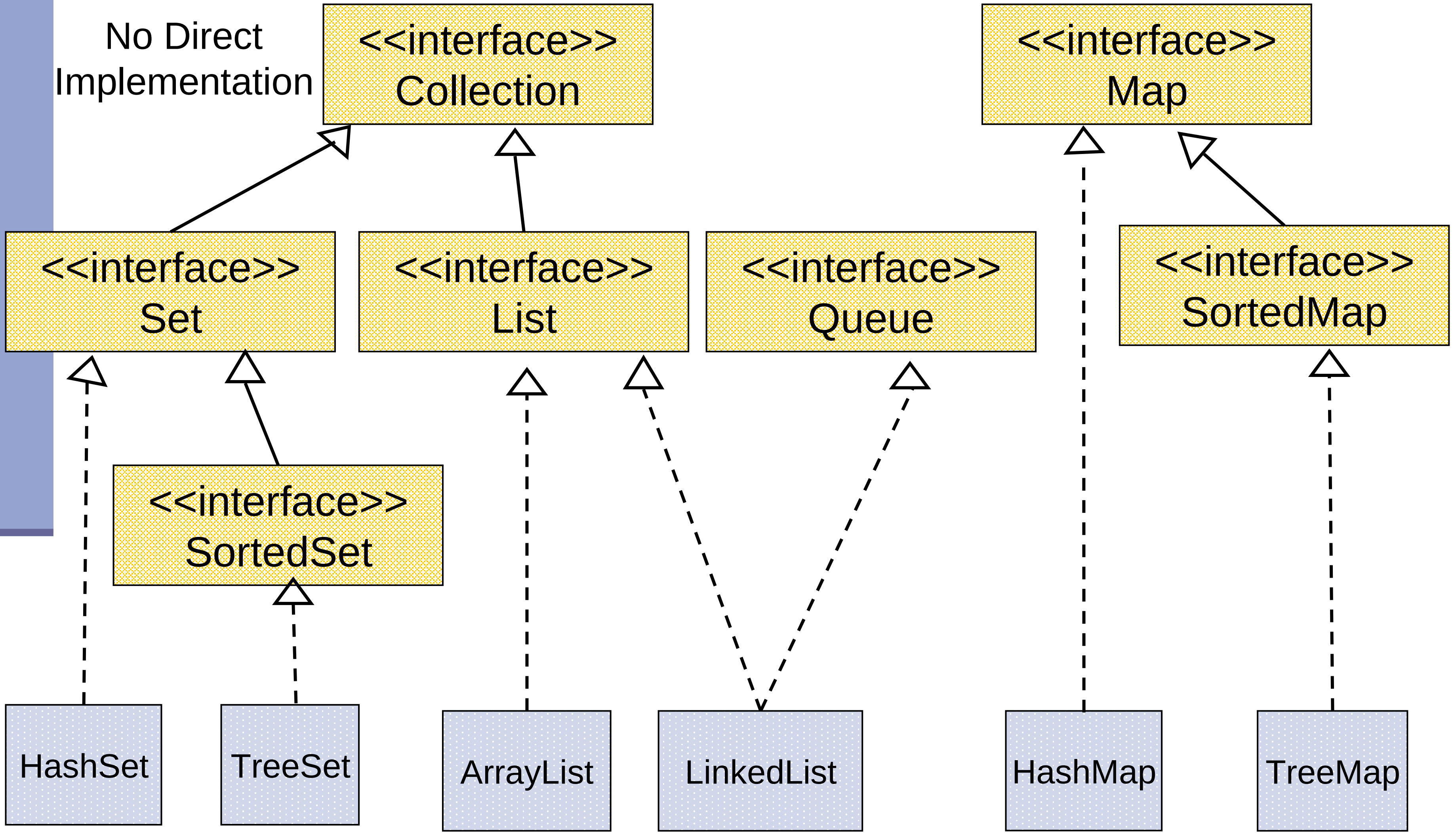
```
for (Iterator iter = collection.iterator()  ;
   iter.hasNext( ); )   {
         System.out.println(iter.next());
}
```

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				LinkedList
	List		ArrayList		LinkedList
	Map	HashMap		TreeMap (SortedMap)	

General Purpose Implementations



Best Practice

- Specify an implementation only when a collection is constructed:
  - $$\underbrace{\texttt{Set}}_{\text{Interface}}\texttt{ s = new }\underbrace{\texttt{HashSet}}_{\text{Implementation}}\texttt{();}$$
  - `public void foo(HashSet s) {…}` **Works, but…**
    `public void foo(Set s) {…}` **Better!**
  - `s.add()` invokes `HashSet.add()`

polymorphism

List Example

```
List list = new ArrayList();
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);
```

Interface

Implementation

List holds Object references (auto-boxing)

List allows duplicates

Invokes List.toString()

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

Insertion order is kept

Output:

```
[3, 1, 1]
```

Set Example

```
Set set = new HashSet();
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]`

Insertion order is
not guaranteed

Queue Example

```
Queue queue = new LinkedList();
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 to the tail of the queue

`remove()` may have no argument – head is removed

Output: `[1, 1, 6]`

FIFO order

Map Example

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

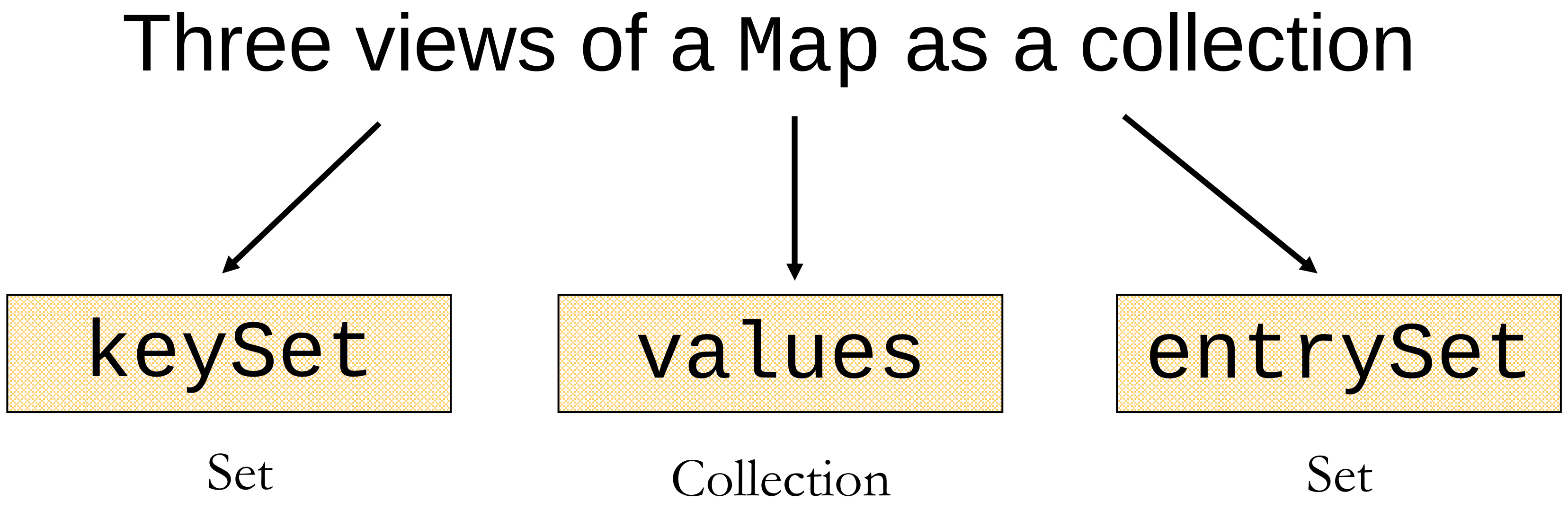
lexicographic order

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



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

Iterating Over the Keys of a Map

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

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

<u>Output</u>:

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

Output:

```
Leo
Dan
Rita
```

Iterating Over the Key-Value Pairs of a Map

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

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

casting

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 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.

<u>Arguments</u>: A C D B

<u>Output</u>: [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);
}
```

- Exception when sorting a list whose elements
  - do not implement `Comparable` or
  - are not *mutually comparable*.

The System.out.printf command

- Useful for exercise 6
- A method of the java.io.PrintStream class
- Format:
  - fixed text + format specifiers
  - `printf(String format, Object... args)`
  - format specifier:
    %[argument_index$][flags][width][.precision]conversion
- A simple example:

```
System.out.printf("hello %s %d!!!\n",
                  "world", 999);
```

Output: `hello world 999!!!`

The System.out.printf command

%[argument_index$][flags][width][.precision]conversion

conversion: s=string (any object), f=float (double, float)
  d=decimal x= hexadecimal (int, byte,short, long)

Example:

```
System.out.printf(
"d=%1$3d,s=%1$-3s,x=%1$x,f=%2$7.3f,%%,", 10,
  12.2);
```

Output:

```
d= 10,s=10 ,x=a,f=12.200 ,%
```