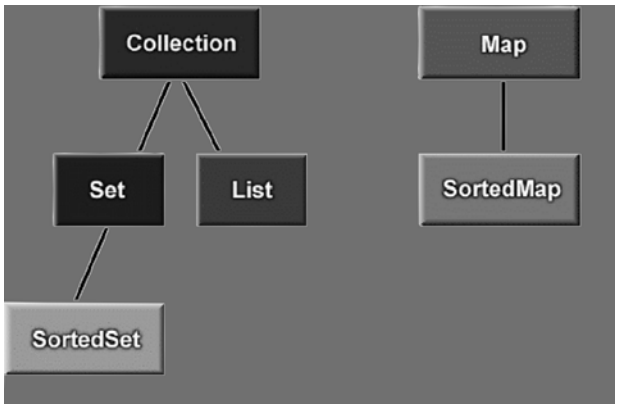
What Is a Collection?

- **A collection (sometimes called a container) is simply an object that groups multiple elements into a single unit**
- **Collections typically represent data items that form a natural group, like a poker hand (a collection of cards), a mail folder (a collection of letters), or a telephone directory (a collection of name-to-phone-number mappings)**

What are the Benefits of Collections?

- **It reduces programming effort**
- **It 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**

Collection: Interfaces



`Collection`: Basic Operations

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

Collection: Bulk Operations

```
…
boolean containsAll(Collection c);
boolean addAll(Collection c);    //
  Optional
boolean removeAll(Collection c); //
  Optional
boolean retainAll(Collection c); //
  Optional
void clear();
…
```

Collection: Array Operations

```
…
Object[] toArray();
Object[] toArray(Object a[]);
…
```

The `Iterator` Interface

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

Using Iterators

```
static void filter(Collection c) {
    for (Iterator i = c.iterator(); i.hasNext();)
        if (!cond(i.next()))
            i.remove();
}
```

- **Note: the code is polymorphic: it works for any Collection that supports element removal, regardless of implementation. That's how easy it is to write a polymorphic algorithm under the collections framework!**

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:

- **Positional Access: manipulate elements based on their numerical position in the list.**
- **Search: search for a specified object in the list and return its numerical position.**
- **List Iteration: extend Iterator semantics to take advantage of the list's sequential nature.**
- **Range-view: perform arbitrary range operations on the list.**

`List`: Positional Access

```
Object get(int index);
Object set(int index, Object element);
  // Optional
void add(int index, Object element);
  // Optional
Object remove(int index);
  // Optional
abstract boolean addAll(int index,
  Collection c); // Optional
```

List: Search

```
int indexOf(Object o);
int lastIndexOf(Object o);
```

List: Iteration

```
ListIterator listIterator();
ListIterator listIterator(int index);
```

`List`: Range-view

```
List subList(int from, int to);
```

Concrete classes implementing `List`

- **ArrayList**
  - **Implements a list using arrays**
- **LinkedList**
  - **Implements a list using linked elements**
- **Vector**
  - **Similar to `ArrayList`, used for backward compatibility**

Object Ordering

There are two ways to order objects:

- **The `Comparable` interface provides automatic natural order on classes that implement it**
- **The `Comparator` interface gives the programmer complete control over object ordering**
- **`Collections.sort(List l)` can be used to order a list using natural order**
- **`Collections.sort(List l, Comparator c)` can be used to order a list depending on the behaviour of c**