Collections

- **collection**: an object that stores data; a.k.a. "data structure"
  - the objects stored are called **elements**
  - some collections maintain an ordering; some allow duplicates
  - typical operations: *add, remove, clear, contains* (search), *size*

- examples found in the Java class libraries: (covered in this course!)
  - `ArrayList`, `LinkedList`, `HashMap`, `TreeSet`, `PriorityQueue`

- all collections are in the `java.util` package
  
  ```java
  import java.util.*;
  ```
• **list**: a collection of elements with 0-based *indexes*
  • elements can be added to the front, back, or elsewhere
  • a list has a **size** (number of elements that have been added)
### List methods

List<String> list = new ArrayList<String>();  // empty
List<Integer> list2 = new LinkedList<Integer>();
list.add("hello");
list.add("goodbye");
System.out.println(list);  // ["hello", "goodbye"]

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>add(value)</td>
<td>adds the given value to the list</td>
</tr>
<tr>
<td>add(index, value)</td>
<td>Adds the given value at the given index to the list</td>
</tr>
<tr>
<td>contains(value)</td>
<td>returns true if the given value is found in this list</td>
</tr>
<tr>
<td>indexOf(value)</td>
<td>returns the index of the given value in the list (-1 if not found)</td>
</tr>
<tr>
<td>remove(value)</td>
<td>removes the given value from the list</td>
</tr>
<tr>
<td>size()</td>
<td>returns the number of elements in list</td>
</tr>
<tr>
<td>isEmpty()</td>
<td>returns true if the list's size is 0</td>
</tr>
<tr>
<td>toString()</td>
<td>returns a string such as &quot;[3, 42, -7, 15]&quot;</td>
</tr>
</tbody>
</table>
Wrapper classes

- A wrapper is an object whose sole purpose is to hold a primitive value.

- Once you construct the list, use it with primitives as normal:

```java
List<Double> grades = new ArrayList<Double>();
grades.add(3.2);
grades.add(2.7);
...
double myGrade = grades.get(0);
```
Exercise

- Write a program that counts the number of unique words in a large text file (say, *Moby Dick* or the King James Bible).
  - Store the words in a collection and report the # of unique words.
  - Once you've created this collection, allow the user to search it to see whether various words appear in the text file.

- What collection is appropriate for this problem?
Sets (11.2)

- **set**: A collection of unique values (no duplicates allowed) that can perform the following operations efficiently:
  - add, remove, search (contains)

- We don't think of a set as having indexes; we just add things to the set in general and don't worry about order.

```
set.contains("to")  # true
set.contains("be")  # false
```
Set implementation

- in Java, sets are represented by `Set` type in `java.util`
- `Set` is implemented by `HashSet` and `TreeSet` classes
  - `TreeSet`: implemented using a "binary search tree"; pretty fast: $O(\log N)$ for all operations
    *elements are stored in sorted order*
  - `HashSet`: implemented using a "hash table" array; very fast: $O(1)$ for all operations
    *elements are stored in unpredictable order*

Note: This $O$(something) notation won’t be covered until next week. It’s okay not to know what it means yet.
Set methods

Set<String> set = new TreeSet<String>();  // empty
Set<Integer> set2 = new HashSet<Integer>();
set.add("hello");
set.add("goodbye");
set.add("hello");
System.out.println(set);  // ["goodbye", "hello"]

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<td>remove(value)</td>
<td>removes the given value from the set</td>
</tr>
<tr>
<td>clear()</td>
<td>removes all elements of the set</td>
</tr>
<tr>
<td>size()</td>
<td>returns the number of elements in list</td>
</tr>
<tr>
<td>isEmpty()</td>
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| toString()      | returns a string such as 

"[3, 42, -7, 15]"