More sophisticated behavior

Using library classes to implement some more advanced functionality

Main concepts to be covered

- Using library classes
- Reading documentation

The Java class library

- Thousands of classes.
- Tens of thousands of methods.
- Many useful classes that make life much easier.
- Library classes are often inter-related.
- Arranged into packages.

Working with the library

- A competent Java programmer must be able to work with the libraries.
- You should:
  - know some important classes by name;
  - know how to find out about other classes.
- Remember:
  - we only need to know the *interface*, not the *implementation*.

A Technical Support System

- A textual, interactive dialog system
- Idea based on *'Eliza'* by Joseph Weizenbaum (MIT, 1960s)
- Explore *tech-support-complete* …

Main loop structure

```
boolean finished = false;

while(!finished) {

    do something

    if(exit condition) {
        finished = true;
    }
    else {
        do something more
    }
}
```

A common iteration pattern.

Main loop body

```
String input = reader.getInput();
...
String response = responder.generateResponse();
System.out.println(response);
```

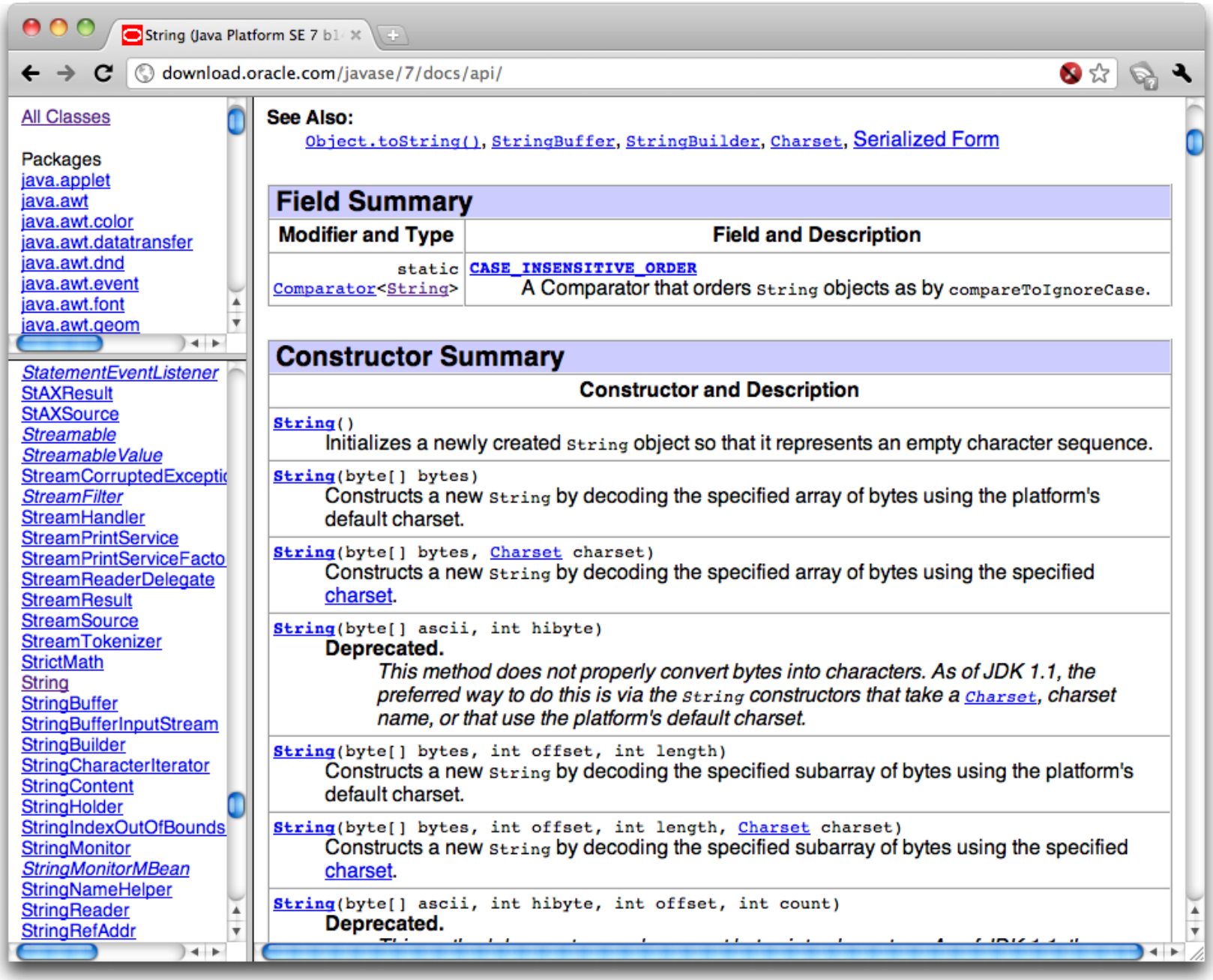
The exit condition

```
String input = reader.getInput();

if(input.startsWith("bye")) {
    finished = true;
}
```

- Where does '**`startsWith`**' come from?
- What is it? What does it do?
- How can we find out?

Reading class documentation

- Documentation of the Java libraries in HTML format;
- Readable in a web browser
- Class API: *Application Programmers' Interface*
- Interface description for all library classes


String (Java Platform SE 7
download.oracle.com/javase/7/docs/api/
All Classes
Packages
java.applet
java.awt
java.awt.color
java.awt.datatransfer
java.awt.dnd
java.awt.event
java.awt.font
java.awt.geom
StatementEventListener
StAXResult
StAXSource
Streamable
StreamableValue
StreamCorruptedExceptio
StreamFilter
StreamHandler
StreamPrintService
StreamPrintServiceFacto
StreamReaderDelegate
StreamResult
StreamSource
StreamTokenizer
StrictMath
String
StringBuffer
StringBufferInputStream
StringBuilder
StringCharacterIterator
StringContent
StringHolder
StringIndexOutOfBounds
StringMonitor
StringMonitorMBean
StringNameHelper
StringReader
StringRefAddr
See Also:
Object.toString(), StringBuffer, StringBuilder, Charset, Serialized Form
Field Summary
Modifier and Type
Field and Description
static Comparator<String>
CASE_INSENSITIVE_ORDER
A Comparator that orders String objects as by compareToIgnoreCase.
Constructor Summary
Constructor and Description
String()
Initializes a newly created String object so that it represents an empty character sequence.
String(byte[] bytes)
Constructs a new String by decoding the specified array of bytes using the platform's default charset.
String(byte[] bytes, Charset charset)
Constructs a new String by decoding the specified array of bytes using the specified charset.
String(byte[] ascii, int hibyte)
Deprecated.
This method does not properly convert bytes into characters. As of JDK 1.1, the preferred way to do this is via the String constructors that take a Charset, charset name, or that use the platform's default charset.
String(byte[] bytes, int offset, int length)
Constructs a new String by decoding the specified subarray of bytes using the platform's default charset.
String(byte[] bytes, int offset, int length, Charset charset)
Constructs a new String by decoding the specified subarray of bytes using the specified charset.
String(byte[] ascii, int hibyte, int offset, int count)
Deprecated.

Interface vs implementation

The documentation includes

- the name of the class;
- a general description of the class;
- a list of constructors and methods
- return values and parameters for constructors and methods
- a description of the purpose of each constructor and method

the *interface* of the class

Interface vs implementation

*The documentation **does not** include*

- private fields (most fields are private)
- private methods
- the bodies (source code) of methods

the *implementation* of the class

Documentation for **startsWith**

- **`startsWith`**
  - `public boolean startsWith(String prefix)`
- Tests if this string starts with the specified prefix.
- Parameters:
  - **`prefix`** - the prefix.
- Returns:
  - **true** if the …; **false** otherwise

Methods from `String`

- **`contains`**
- **`endsWith`**
- **`indexOf`**
- **`substring`**
- **`toUpperCase`**
- **`trim`**
- Beware: strings are *immutable*!

Using library classes

- Classes organized into packages.
- Classes from the library must be *imported* using an **`import`** statement (except classes from the **`java.lang`** package).
- They can then be used like classes from the current project.

Packages and import

- Single classes may be imported:

```
import java.util.ArrayList;
```

- Whole packages can be imported:

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

- Importation does not involve source code insertion.

Using Random

- The library class **`Random`** can be used to generate random numbers

```
import java.util.Random;
...
Random rand = new Random();
...
int num = rand.nextInt();
int value = 1 + rand.nextInt(100);
int index = rand.nextInt(list.size());
```

Selecting random responses

```
public Responder()
{
    randomGenerator = new Random();
    responses = new ArrayList<String>();
    fillResponses();
}

public void fillResponses()
{
    fill responses with a selection of response strings
}

public String generateResponse()
{
    int index = randomGenerator.nextInt(responses.size());
    return responses.get(index);
}
```

Parameterized classes

- The documentation includes provision for *a type parameter*:
  - **`ArrayList<E>`**
- These type names reappear in the parameters and return types:
  - **`E get(int index)`**
  - **`boolean add(E e)`**

Parameterized classes

- The types in the documentation are placeholders for the types we use in practice:
  - An **`ArrayList<TicketMachine>`** actually has methods:
  - **`TicketMachine get(int index)`**
  - **`boolean add(TicketMachine e)`**

Review

- Java has an extensive class library.
- A good programmer must be familiar with the library.
- The documentation tells us what we need to know to use a class (its interface).
- Some classes are parameterized with additional types.
  - Parameterized classes are also known as *generic classes* or *generic types*.

More sophisticated behavior

Using library classes to implement some more advanced functionality

Main concepts to be covered

- Further library classes
  - **`Set`**
  - **`Map`**
- Writing documentation
  - **`javadoc`**

Using sets

```
import java.util.HashSet;

...
HashSet<String> mySet = new HashSet<String>();

mySet.add("one");
mySet.add("two");
mySet.add("three");

for(String element : mySet) {
    do something with element
}
```

Compare with code for an `ArrayList`!

Tokenising Strings

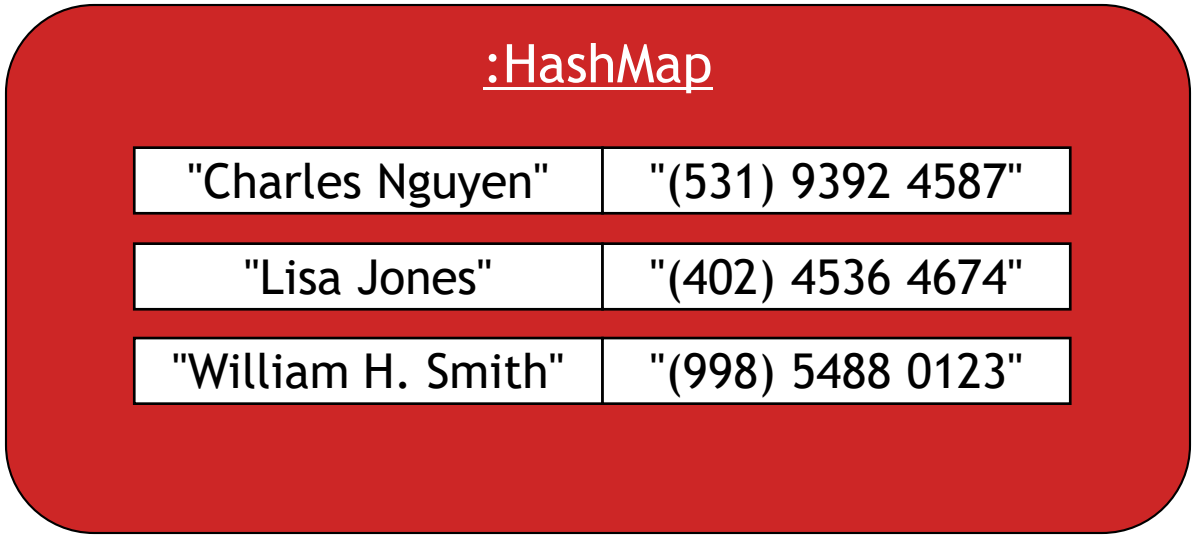
```
public HashSet<String> getInput()
{
    System.out.print("> ");
    String inputLine =
        reader.nextLine().trim().toLowerCase();

    String[] wordArray = inputLine.split(" ");
    HashSet<String> words = new HashSet<String>();

    for(String word : wordArray) {
        words.add(word);
    }
    return words;
}
```

Maps

- Maps are collections that contain pairs of values.
- Pairs consist of a key and a value.
- Lookup works by supplying a key, and retrieving a value.
- Example: a telephone book.

Using maps

- A map with strings as keys and values



Using maps

```
HashMap <String, String> phoneBook =
                new HashMap<String, String>();

phoneBook.put("Charles Nguyen", "(531) 9392 4587");
phoneBook.put("Lisa Jones", "(402) 4536 4674");
phoneBook.put("William H. Smith", "(998) 5488 0123");

String phoneNumber = phoneBook.get("Lisa Jones");
System.out.println(phoneNumber);
```

`List`, `Map` and `Set`

- Alternative ways to group objects.
- Varying implementations available:
  - **`ArrayList`**, **`LinkedList`**
  - **`HashSet`**, **`TreeSet`**
- But **`HashMap`** is unrelated to **`HashSet`**, despite similar names.
- The second word reveals organizational relatedness.

Writing class documentation

- Your own classes should be documented the same way library classes are.
- Other people should be able to use your class without reading the implementation.
- Make your class a potential 'library class'!

Elements of documentation

Documentation for a class should include:

- the class name
- a comment describing the overall purpose and characteristics of the class
- a version number
- the authors' names
- documentation for each constructor and each method

Elements of documentation

The documentation for each constructor and method should include:

- the name of the method
- the return type
- the parameter names and types
- a description of the purpose and function of the method
- a description of each parameter
- a description of the value returned

javadoc

Class comment:

```
/**
 * The Responder class represents a response
 * generator object. It is used to generate an
 * automatic response.
 *
 * @author     Michael Kölling and David J. Barnes
 * @version    1.0  (2011.07.31)
 */
```

javadoc

Method comment:

```
/**
 * Read a line of text from standard input (the text
 * terminal), and return it as a set of words.
 *
 * @param  prompt  A prompt to print to screen.
 * @return A set of Strings, where each String is
 *         one of the words typed by the user
 */
public HashSet<String> getInput(String prompt)
{
    ...
}
```

Public vs private

- Public elements are accessible to objects of other classes:
  - Fields, constructors and methods
- Fields should not be public.
- Private elements are accessible only to objects of the same class.
- Only methods that are intended for other classes should be public.

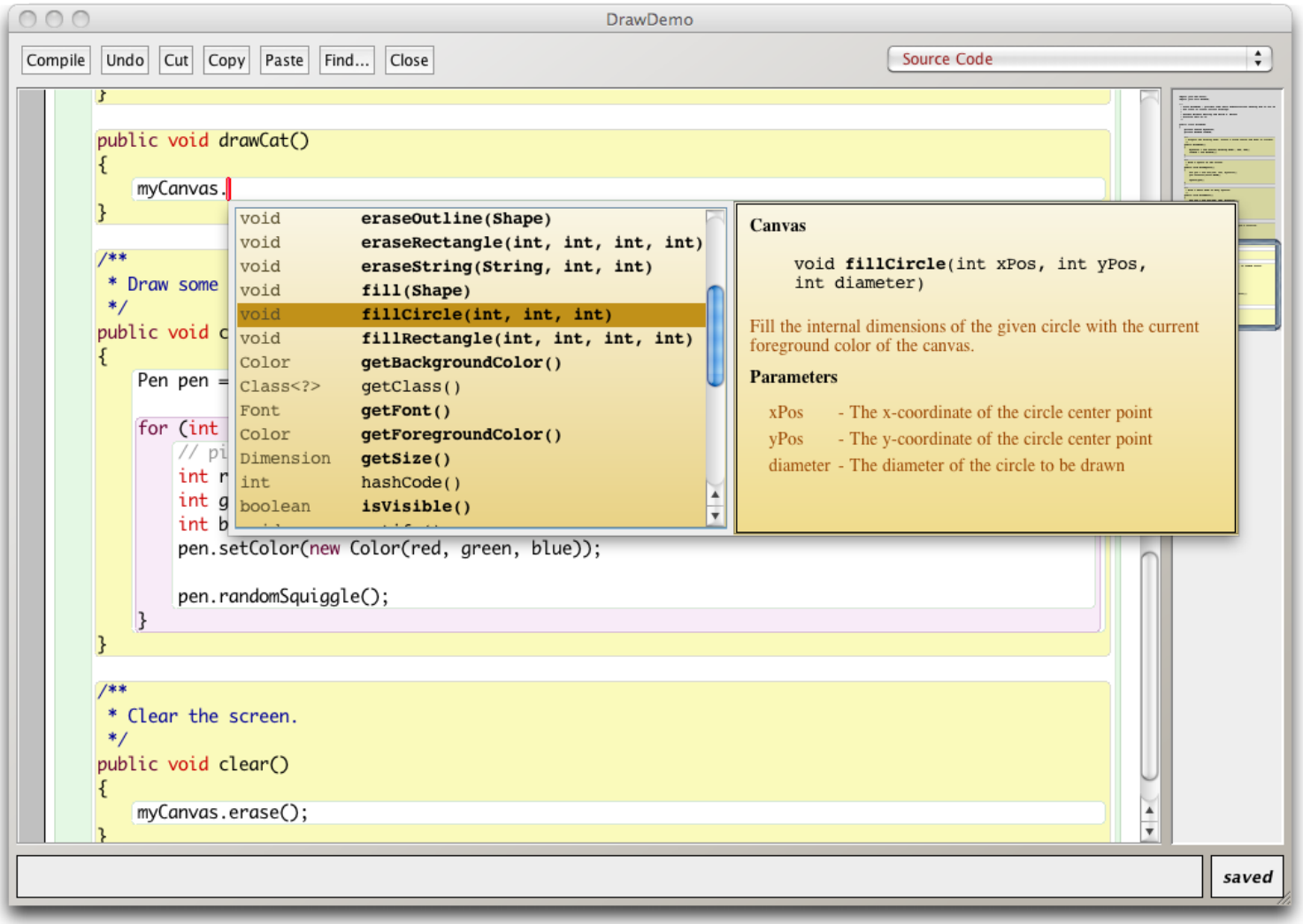
Information hiding

- Data belonging to one object is hidden from other objects.
- Know what an object can do, not how it does it.
- Information hiding increases the level of *independence*.
- Independence of modules is important for large systems and maintenance.

Code completion

- The BlueJ editor supports lookup of methods.
- Use Ctrl-space after a method-call dot to bring up a list of available methods.
- Use *Return* to select a highlighted method.

Code completion in BlueJ



Review

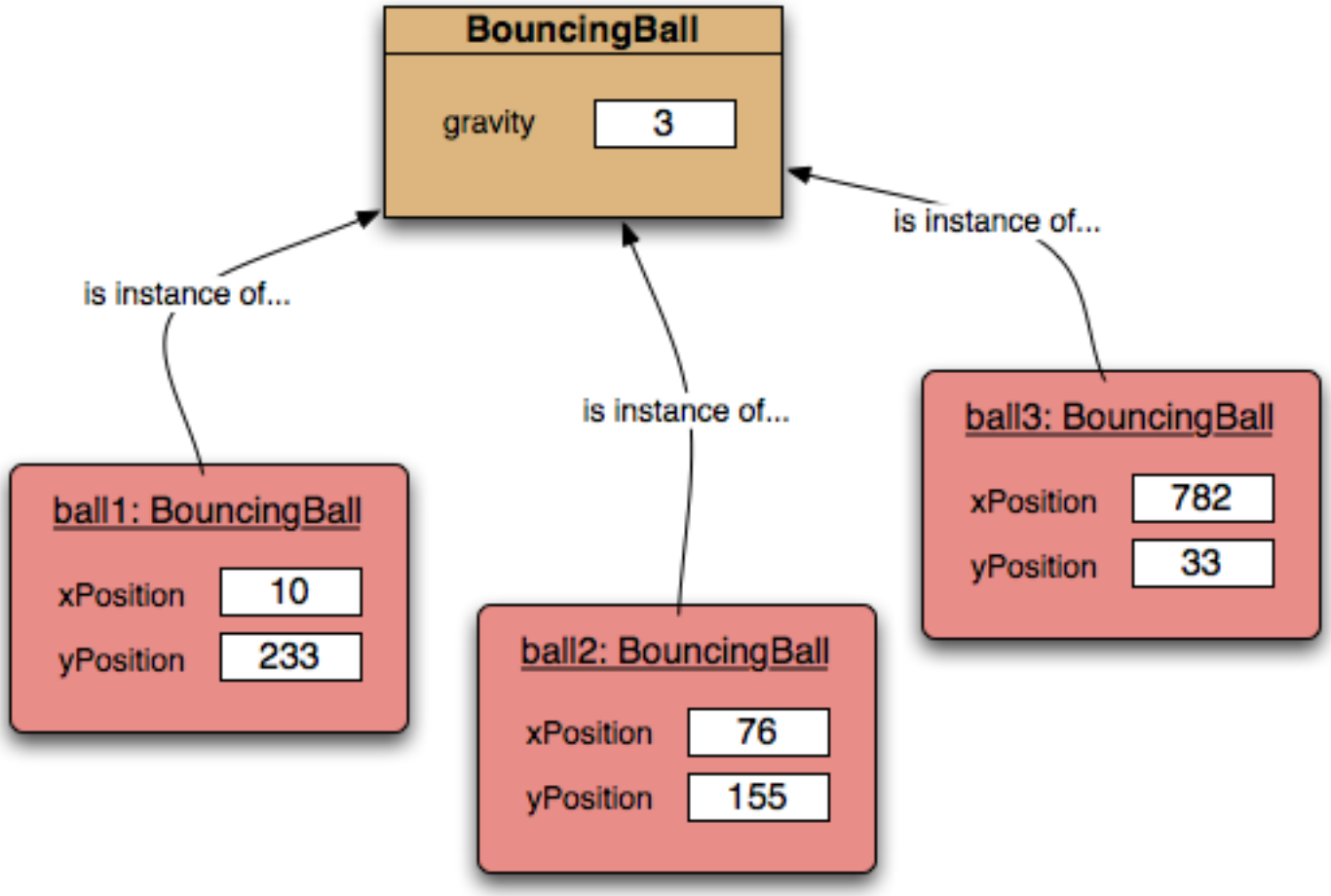
- Java has an extensive class library.
- A good programmer must be familiar with the library.
- The documentation tells us what we need to know to use a class (interface).
- The implementation is hidden (information hiding).
- We document our classes so that the interface can be read on its own (class comment, method comments).

Class and constant variables

Class variables

- A class variable is shared between all instances of the class.
- In fact, it belongs to the class and exists independent of any instances.
- Designated by the **`static`** keyword.
- Public static variables are accessed via the class name; e.g.:
  - **`Thermometer.boilingPoint`**

Class variables



Constants

- A variable, once set, can have its value fixed.
- Designated by the **`final`** keyword.
  - **`final int max = list.size();`**
- Final *fields* must be set in their declaration or the constructor.
- Combing **`static`** and **`final`** is common.

Class constants

- **`static`**: class variable
- **`final`**: constant

```
private static final int gravity = 3;
```

- Public visibility is less of an issue with **`final`** fields.
- Upper-case names often used for class constants:

```
public static final int BOILING_POINT = 100;
```