More sophisticated behavior

Using library classes to implement some more advanced functionality

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The Java class library

- Thousands of classes
- Tens of thousands of methods
- Many useful classes that make life much easier
- A competent Java programmer must be able to work with the libraries.

Working with the library

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.

Example

```
String str = "Some example string";
if (str.startsWith("something")) {
    // do something ...
}
```

- 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 Programming Interface
- Interface description for all library classes

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) for each method

→ **the *implementation* of the class**

Using library classes

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

Packages and import

- Classes are organised in packages.
- Single classes may be imported:

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

- Whole packages can be imported:

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

Information Hiding

- The principle of Information Hiding states that internal details of a class’s implementation should be hidden from other classes.

- It ensures better modularization of an application.

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.

public vs private

- Public members (fields, constructors, methods) are accessible to all other classes.
- Private members are accessible only within the same class.

default / package access

- Not specifying any access modifier means “default access”, or “package-private”.
- Package access members are accessible to any class within the same package.

Which access modifier ?

- Classes can be:
  - public
  - package-private (no-modifier)
- Fields, constructors, and methods:
  - public
  - package-private (no-modifier)
  - private
  - protected

Which access modifier ?

- According to the principle of “Information Hiding”, programmers should **use the most restrictive** access modifier possible.
- Simply, prefer “private” over “public” whenever possible.
- Generally:
  - Almost all fields must be private.
  - Methods that implement a behaviour of this class must be public.
  - Methods with internal usage must be private.

NOTE

- Class access takes precedence over any access modifiers for members.
- A package-private class is not accessible to other classes outside the package; including all of its public members.

final / constant fields

- Class fields can be declared constant, using the “**final**” keyword.
- Final / constant fields can be initialized at the constructor.
- By convention, Java programmer use ALL_CAPS names for final fields.

```
private final int SIZE = 10;
```

static / class members

- The "static" keyword is used to specify **class members**.
- Class members don't need an object to be accessed; they are accessible using the class name.
- Values of class members are **shared** among all objects.

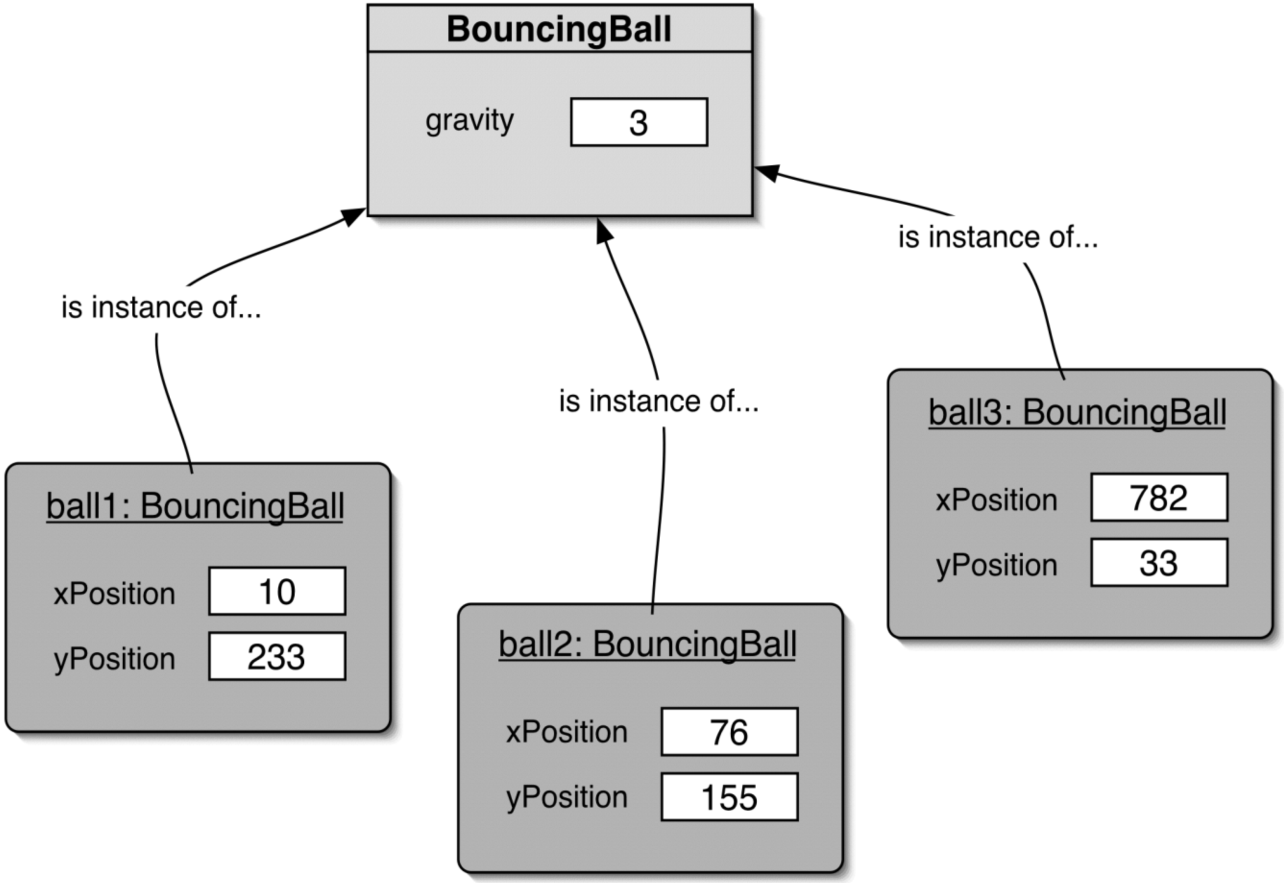
```
public class Animal {
    private static int count = 0;
    ...
```

static + final = Class variable

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

- `private`: access modifier, as usual
- `static`: class variable
- `final`: constant

Class variables



Immutability

- Immutable objects are objects that once they are created, their state cannot be modified.

```
public class ImmutableClass {
    private int value;
    public ImmutableClass(int value) {
        this.value = value;
    }
    public int getValue() {
        return value;
    }
}
```

Immutability

- A well-know immutable class in Java is the “String” class.

```
String str = "testing";
str.toUpperCase();
System.out.println(str); // prints:  testing

str = str.toUpperCase();
System.out.println(str); // prints:  TESTING
```

Side note: String equality

```
if (input == "bye") {
    ...
}
```

tests identity

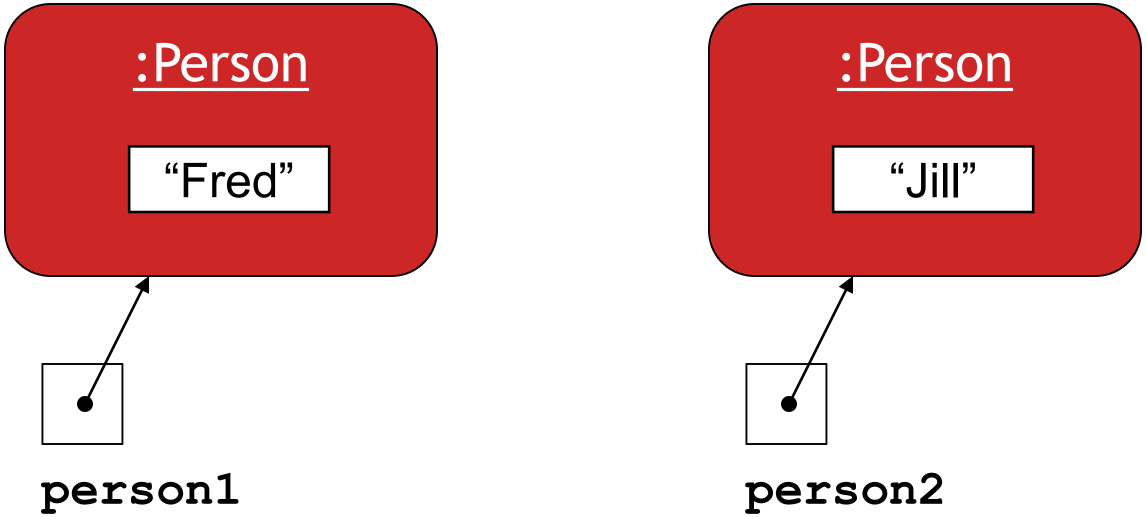
```
if (input.equals("bye")) {
    ...
}
```

tests equality

- Strings should always be compared with `.equals`

Identity vs equality

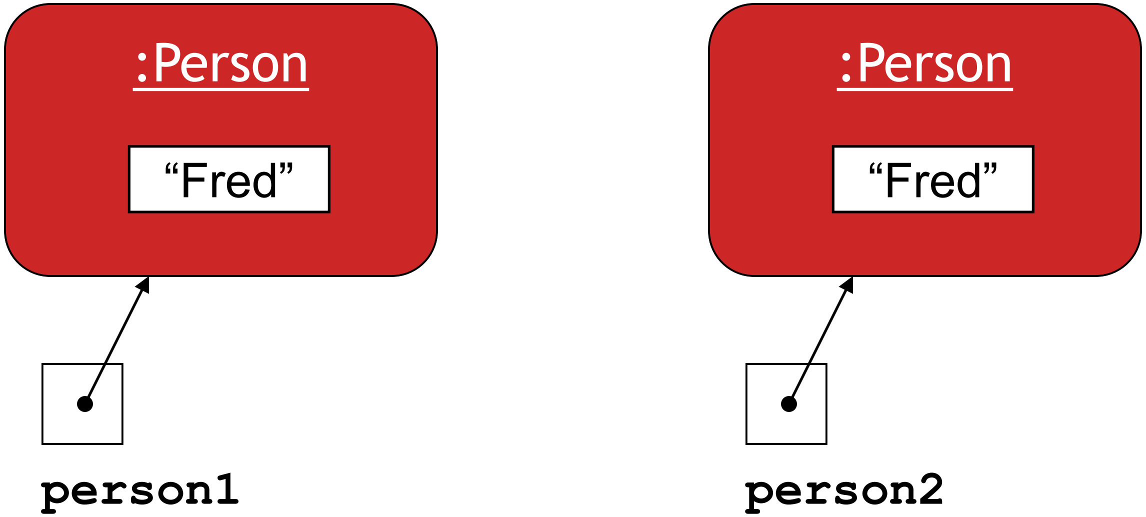
Other (non-String) objects:



`person1 == person2 ?`

Identity vs equality

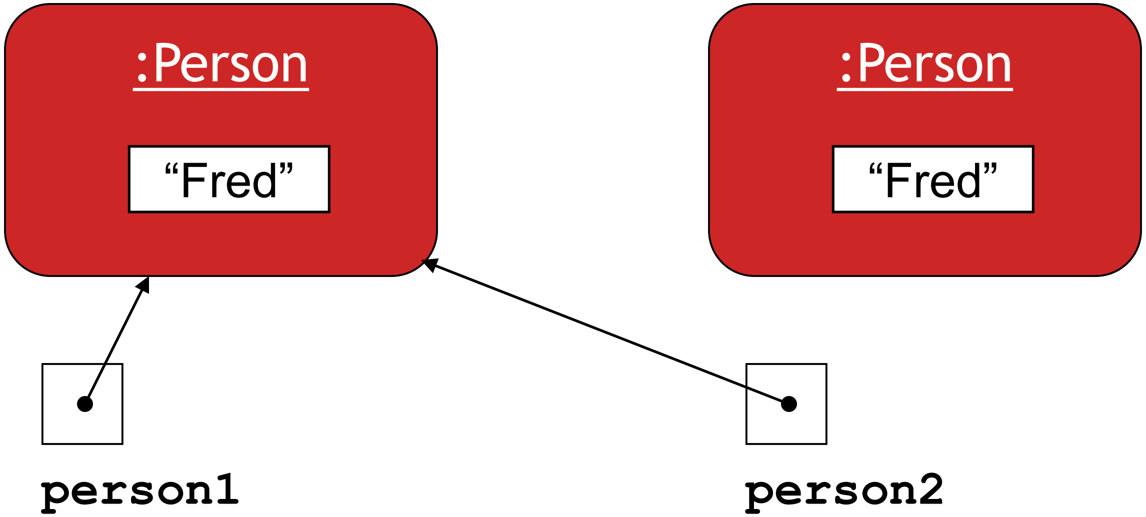
Other (non-String) objects:



`person1 == person2 ?`

Identity vs equality

Other (non-String) objects:

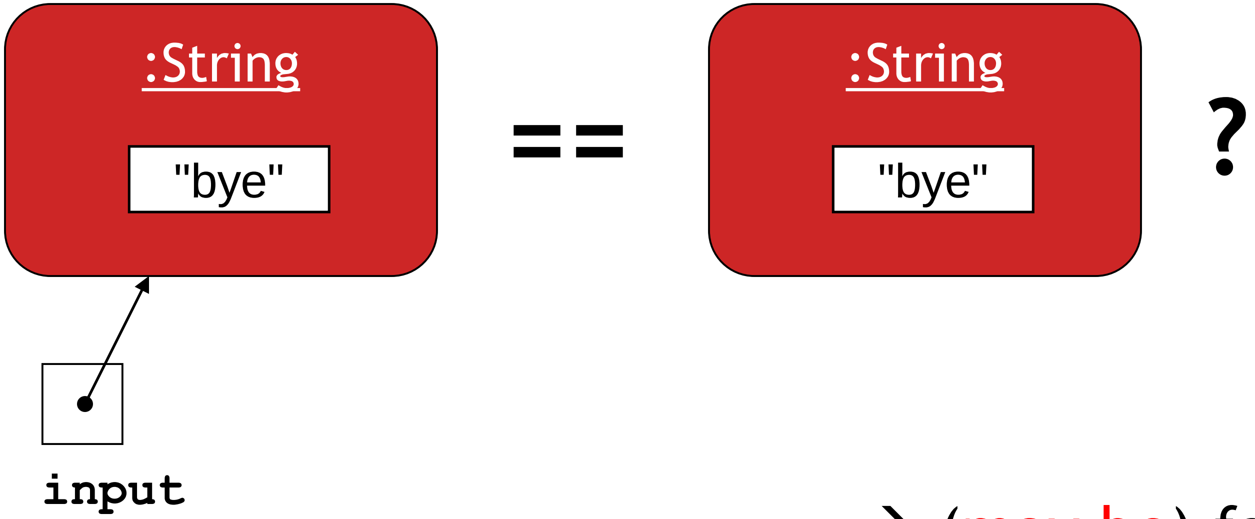


`person1 == person2 ?`

Identity vs equality (Strings)

```
if (input == "bye") {
    ...
}
```

== tests identity

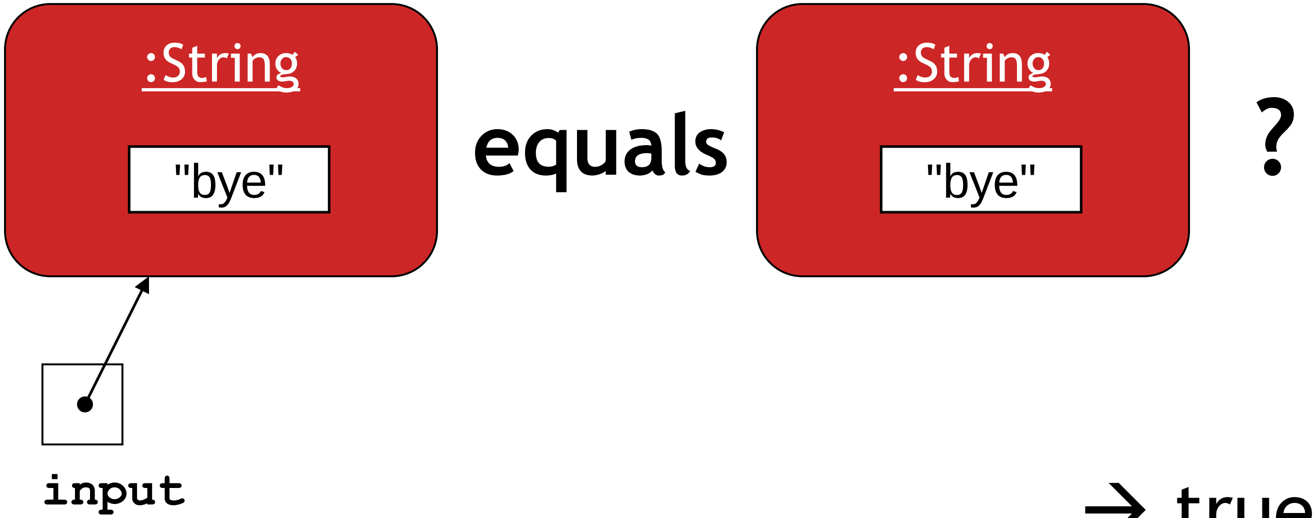


→ (may be) false!

Identity vs equality (Strings)

```
String input = reader.getInput();
if (input.equals("bye")) {
    ...
}
```

equals tests equality



→ true!

Using Random

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

```
import java.util.Random;
...
Random randomGenerator = new Random();
...
int index1 = randomGenerator.nextInt();
int index2 = randomGenerator.nextInt(100);
```

Generating random responses

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

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

public void fillResponses() {
   ...
}
```

Using sets

```
import java.util.HashSet;
import java.util.Iterator;
...
HashSet<String> mySet = new HashSet<String>();

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

Iterator<String> it = mySet.iterator();
while(it.hasNext()) {
    call it.next() to get the next object
    do something with that object
}
```

Compare this to ArrayList code!

Tokenizing Strings

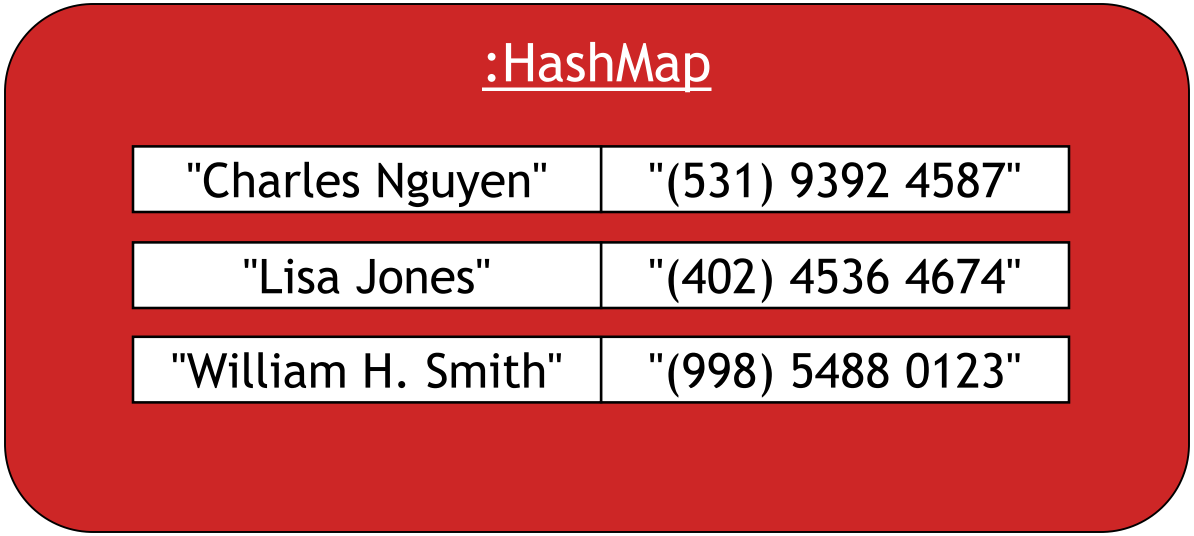
```
public HashSet<String> getInput()
{
    Scanner reader = new Scanner(System.in);
    System.out.print("> ");
    String inputLine =
            reader.nextLine().trim().toLowerCase();
    String[] wordArray = inputLine.split(" ");
    HashSet<String> words = new HashSet<String>();

    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.
- An example: a telephone book.

Using maps

- A map with Strings as keys and values



:HashMap

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

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);
```

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 '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
- the authors' names
- a version number
- documentation for each constructor and each method

Elements of documentation

The documentation for each constructor and method should include:

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

javadoc

```
// This is a single line comment

/*
  This is a regular multi-line comment
  This is the third line of the comment
 */

/**
 * This is a Javadoc
 */
```

https://www.oracle.com/technetwork/java/javase/documentation/index-137868.html#format

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  (30.Mar.2006)
 */
public class Responder {
...
}
```

javadoc

Method comment:

```
/**
 * Reads a line of text from standard input (the text
 * terminal), and return it as a set of words. It
 * splits text into 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)
{
   ...
}
```

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).