More on Java (cont.)

Object-Oriented Programming

Outline

- Static methods
- Static variables (class variables)
- Packages

- Readings:
  - HFJ: Ch. 10.
  - GT: Ch. 10.

Class methods

- Examples:

```
double x = Math.round(42.2);
int y = Math.abs(-10);
```

- Methods in the Math class don't use any instance variable values. So they don't need to know about a specific Math object. All we need is the Math class.
- They were written as class methods – **static** methods.

- A class method (static method) is one that runs *without any instance of the class*.

Regular methods vs. static methods

Regular methods

```
class Cow {
  String name;
  public String greeting() {
    return ("Hi, I am " + name);
  }
}
```

- instance variable *name* affects the behavior of greeting()
- MUST be called using a reference variable

```
s = cow1.greeting();
```

Static methods

```
class Math {
  public static int abs(int a) {
    if (a > 0) return a;
    return -a;
  }
...
```

- abs() has absolutely nothing to do with any Math instance variables
- CAN be called using the class name:

```
int a = Math.abs(-10);
```

This won't compile

```
public class Duck {

  private int size;

  public static void main( String[] args) {
    System.out.println("Size of duck is " + size);
  }

  public void setSize (int s) {
    if (s>0) size = s;
  }
  public int getSize() {
    return size;
  }
}
```

Which duck? Whose size?

If there's a duck or ten ducks on the heap somewhere, the static method doesn't know about any of them.

```
File Edit Window Help Quack
% javac Duck.java
Duck.java:6: non-static variable
size cannot be referenced from a
static context
      System.out.println("Size
of duck is " + size);
                 ^
```

I've no idea which duck you are talking about!

Static method can't use instance variables or non-static methods

- Static methods can be called using class name
  - → no **`this`** reference, no owner object

```
public class Duck {

  private int size;

  public static void main( String[] args) {
    Duck d = new Duck();
    setsize(10);
    System.out.println("Size of duck is " + size);
  }

  public void setSize (int s) {…}
...
```

Whose are they?
Which duck?

Static variables – class variables

- A class variable belong to the class, not any object.
- One copy shared among all class instances.

```
public class Duck {

  private int size;
  public static int count = 0;

  public Duck() {
    count++;
  }
  ...
```

Each duck has its own `size`. But all ducks share the same `count`.

Static variables – class variables

```
public class Duck {

  private int size;
  public static int count = 0;

  public Duck() {
    count++;
  }
  ...
```

```
public class DuckTestDrive {
  public static void main(String [] args) {
    System.out.println(Duck.count);
    Duck d = new Duck();
    System.out.println(d.count);
  }
}
```

```
% java DuckTestDrive
0
1
```

before any ducks are made

after the first duck is created

Class variables vs. Instance variables

Class/static variables

- belong to a class
- one copy shared among all instances of the class
- initialized before any objects of the class

Instance variables

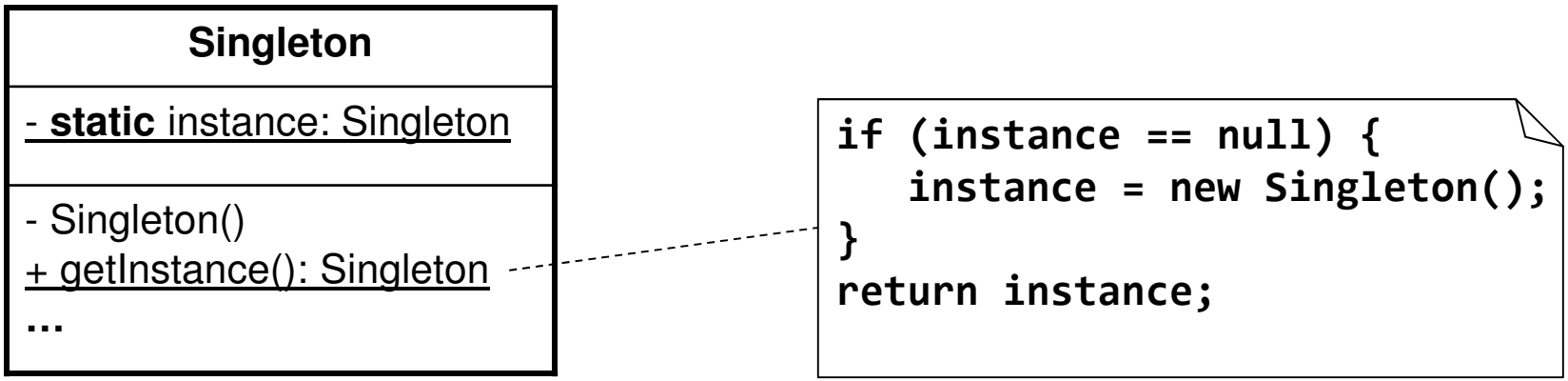
- belong to an instance
- each instance has its own copy
- initialized when the owner object is created

```
public class Duck {
  private int size = 0;
  public static int count = 0;

  public Duck() {
    count++;
    size++;
  }
```

Design pattern : Singleton

- Singleton: Ensure a class has only ONE instance, and provide a global point of access to it.



- Uses
  - In place of global variables
  - In system resource management
    - Avoid conflicting accesses from concurrent processes

Package: Declaration

- a **package** statement appears as the first non-comment in the file

package declaration with package name. The rest of the file belongs to the same package

```
// HelloMsg.java
package hanv;

public class HelloMsg {
   public void sayHello() {
      System.out.println("Hello, world!");
   }
}
```

Declared as **public** so that they can be used outside package **hanv**

Package: Usage

- Two ways:

1. Use the **import** statement to make the name(s) in the package available, once for all

```
//Hello.java
import hanv.HelloMsg;

public class Hello {
    public static void main(String[] args) {
        HelloMsg msg = new HelloMsg();
        msg.sayHello();
    }
}
```

2. Give the fully qualified name at every call

```
//Hello.java
public class Hello {
    public static void main(String[] args) {
        hanv.HelloMsg msg = new hanv.HelloMsg();
        msg.sayHello();
    }
}
```

Package – Compile and run

- Compile

```
javac HelloMsg.java -d <class_root_dir>
javac Hello.java
```

- Run

```
java Hello
```

Package – make it simple

- Where to put source files?
  - C:\java root directory
  - C:\java\hanv classes in hanv package

- Compile: stay at the root!
  - `C:\java\> javac hanv\HelloMsg.java`
  - equivalent to `javac hanv\HelloMsg.java -d .`
  - or `javac hanv\HelloMsg.java -d c:\java`

  - `C:\java\> javac Hello.java`

- Run
  - `C:\java\> java Hello`
  - `C:\java\> java hanv.HelloMsg` (if HelloMsg is a program)