

CMSC 131: Chapter 20 (Supplement)

Packages

Java Program Organization

Program Organization:

- **Java program:** is composed of **1 or more Java source files**.
- **Source file:** can have **1 or more class and/or interface declarations**. (In our projects we have implemented one class/interface per file.)
- **Public Class/Interface:** If a class/interface is declared **public** the source file must use the **same name**.
- Only **one public class/interface** is allowed **per source file**. (Can you have non-public classes? We will discuss this later.)
- **Packages:** When a program is very large, its classes can be further organized **hierarchically** into packages.

Packages

Package: a collection of **related** classes and/or interfaces.

Examples: The Java API

javax.swing: classes dealing with the development of GUIs.
java.lang: essential classes required by the Java language.
java.text: facilities for formatting text output.
java.util: classes for storing/accessing collections of objects.
java.net: for network communication.

Hierarchical: Packages can be **divided** into subpackages.

java.awt: classes for basic GUI elements and graphics.
 java.awt.font: classes and interface relating to fonts.
 java.awt.geom: classes for defining 2-dimensional objects.

There is no limit to the nesting depth.

Access to Package Members

Review of Package Basics:

Accessing Package Members:

Fully qualified name: E.g., `javax.swing.JOptionPane`

Importing a single class:

```
import javax.swing.JOptionPane;
...
JOptionPane.showMessageDialog( ... );
```

Importing all the classes:

```
import javax.swing.*;
...
JOptionPane.showMessageDialog( ... );
```

Import semantics: `import` does not "insert" the Java files (as C/C++ do with "include" files). Instead, it tells the compiler **where to look** to find classes that the program refers to.

Multiple import statements: You can have as many as you like. They go **at the top of your .java** file (before any classes or interfaces).

`java.lang`: is automatically imported into every program.

Defining your own package

Why packages? Packages enable a programmer organize the code into smaller logically related units. A large program may consists of hundreds of classes. (Although we may not need to use them for the little projects in CMSC 131, but it is important to know how to create packages for when you will need them.)

Every class is part of some package: Really? Why haven't we seen more of them?

Default package: If you do not specify a package a class becomes part of the "**default package**".

What special privileges do packages provide? Classes defined within the same package can access one another more easily (without the need for importing or fully qualified names).

Defining your own package

Defining a package: Add a "package" statement to specify the package containing the classes of this file.

```
package mypackage;
...
public class myClass { ... } // myClass is part of mypackage
```

This must be the **first statement** of your file. (Other than comments.)

Subpackages: Packages can be organized into subpackages. This is specified using the notation "main.subpackage". Example:

```
package mypackage.mysubpackage;
...
public class myClass2 { ... } // myClass2 is part of mysubpackage
// ... which is within mypackage
```

Packages in Eclipse: File→New→Package. Enter the full name of the package (e.g. "mypackage" or "mypackage.mysubpackage").

Without Eclipse: Just insert this yourself ("package mypackage;")

Class Access and Packages

Class access within a package:

- Classes within a package can refer to each other **without full qualification**.
- If a class is **not** declared **public**, it can **only** be accessed by other classes **within the package**.

Class access across packages:

- A **public class** can be accessed from **other packages**.
- When this is done, either its name is **fully qualified** or is **imported**.
- We can view **public classes of a package** as the "**interface**" of the package with the outside world. (This is analogous to public methods of a class forming its interface.)

Example

To illustrate these points, let's consider a (contrived) example of a hierarchical package that we will create.

```
graphics
  graphics.shapes
  graphics.otherstuff
```

Example: graphics.shapes package

File: Circle.java

```
package graphics.shapes;
public class Circle {
    private double radius;
    public String toString( ) { return "I'm a circle"; }
}
```

File: Rectangle.java

```
package graphics.shapes;
public class Rectangle {
    private double height, width;
    public String toString( ) { return "I'm a rectangle"; }
}
```

File: Othershape.java

```
package graphics.shapes;
public class OtherShape {
    private Circle c;      // Can access other classes in this package directly
    private Rectangle r;
}
```

Example: graphics.otherstuff package

File: PublicClass1.java

```
package graphics.otherstuff;
public class PublicClass1 {          // A public class
    public String toString() {
        return "This is a PublicClass: " + NonPublicClass1.message( );
    }
}
class NonPublicClass1 {            // A nonpublic class: Only accessible in the package
    static public String message( ) { return "I'm a nonpublic class"; }
}
```

File: PublicClass2.java

```
package graphics.otherstuff;
public class PublicClass2 {
    private Driver d;                // NO! We have no direct access to parent package
    private Circle c1;               // NO! We have no direct access to sister package
    private graphics.shapes.Circle c2; // Okay. Can access public classes elsewhere

    public String toString( ) {
        return "This is a PublicClass2: " + NonPublicClass1.message( );
    }
}
```

Example: graphics.package

File: Driver.java

```
package graphics;
import graphics.shapes.Circle;

public class Driver {
    public static void main(String[] args) {
        testShapes( );
        testOtherStuff( );
    }

    public static void testShapes( ) {
        Circle c = new Circle( );
        System.out.println( c.toString( ) );
        Rectangle r = new Rectangle( );        // NO! Cannot access without import
    }

    public static void testOtherStuff( ) {
        PublicClass1 x = new PublicClass1( );    // NO! Cannot access without import
        graphics.otherstuff.PublicClass1 y = new graphics.otherstuff.PublicClass1( );
        System.out.println( y );
        graphics.otherstuff.NonPublicClass1 z;  // NO! not visible here
    }
}
```

File Structure

Java organizes the package files using your system's directory structure.

graphics:

```
Driver.class  Driver.java
otherstuff/
shapes/
```

graphics/otherstuff:

```
NonPublicClass1.class
PublicClass1.java    PublicClass2.java
PublicClass1.class  PublicClass2.class
```

graphics/shapes:

```
Circle.class    OtherShape.class  Rectangle.class
Circle.java     OtherShape.java   Rectangle.java
```

Packages and .jar Files

Packages are convenient, but large directories are not.

Jar File: Java allows you to **bundle up an entire directory** of files into a single file, called a **jar file**.

Creating a jar file:

- **In Eclipse:** In the Package Explorer window, right click on the project and select "**Export → JAR file**".
- **On Unix:**

```
jar -cvf myJarFile.jar ... (list the file names and/or directories)
```

(c = create; t = list names; x = extract; v = verbose; f = jar file)

Examples:

cmssc131PictureLib.jar: A jar file we created for the picture library.

cmssc131PuzzleLib.jar: A jar file we created for HW#5.

C:\...\Java\j2re1.4.2_05\lib\rt.jar: This is a large (20+Mbyte) file with all the class files from the Java runtime library.

Packages and Classpath

You may have many different packages on your system (e.g. the Java runtime library, cmssc131PictureLib, cmssc131PuzzleLib) in many different locations. **How does Java know where to look for them?**

ClassPath: is a system **environment variable** that gives a list of directories and jar files where Java should look up its classes.

Windows Example: Suppose we want to use

- **graphics package:** stored in directory C:\MyJavaPackages\graphics.
- **cmssc131PictureLib.jar:** stored in C:\MyJars\cmssc131PictureLib.jar
- classes compiled in the **current working directory:** The current directory is denoted by "." (period) on most systems.

```
C:\>set CLASSPATH=.;C:\MyJavaPackages;C:\MyJars\cmssc131PictureLib.jar
```

Packages and Classpath

In Eclipse: The ClassPath is already set with important default directories (e.g. the Java runtime library). To modify the ClassPath:

- In the **Package Explorer**, right click on the project name
- Select "**Properties** → **Java Build Path** → **Libraries**"
- **To add Jars:** Select: "**Add External JARs...**" and browse for the file name.
- **To add a directory to the ClassPath:** Select:

Add Variable... → **Configure Variables** → **New**

and add the name of the new directory.