CS61B Lecture #13: Packages, Access, Loose E

- Modularization facilities in Java.
- Importing
- Nested classes.
- Using overridden method.
- Parent constructors.
- Type testing.

Package Mechanics

- Classes correspond to things being modeled (represented) program.
- Packages are collections of "related" classes and other pack
- Java puts standard libraries and packages in package `java` an
- By default, a class resides in the *anonymous package.*
- To put it elsewhere, use a `package` declaration at start of f

```
package database;     or     package ucb.util;
```

- Oracle's `javac` uses convention that class `C` in package `P1.P2` subdirectory `P1/P2` of any other directory in the *class path*
- Unix example:

```
$ export CLASSPATH=.:$HOME/java-utils:$MASTERDIR/lib/classe
$ java junit.textui.TestRunner MyTests
```

Searches for TestRunner.class in ./junit/textui, ~/java-utils and finally looks for junit/textui/TestRunner.class in the file (which is a single file that is a special compressed archi entire directory of files).

Access Modifiers

- Access modifiers (**private**, **public**, **protected**) do not add c to the power of Java.
- Basically allow a programmer to declare which classes are s to need to access ("know about") what declarations.
- In Java, are also part of security—prevent programmers f cessing things that would "break" the runtime system.
- Accessibility always determined by static types.
  - To determine correctness of writing `x.f()`, look at the de of `f` in the *static type* of `x`.
  - Why the static type? Because the rules are supposed to forced by the compiler, which only knows static types o (static types don't depend on what happens at execution

The Access Rules: Public

- Accessibility of a member depends on (1) how the member' ration is qualified and (2) where it is being accessed.
- C1, C2, C3, and C4 are distinct classes.
- Class C2a is either class C2 itself or a subtype of C2.

```
package P1;
public class C1 ... {
  // M is a method, field,...
  public int M ...
  void h(C1 x)
    { ... x.M ... } // OK.
}
-----------------------------
package P1;
public class C4 ... {
  void p(C1 x)
    { ... x.M ... } // OK.
}
```

```
package P2;
class C2 extends C3 {
  void f(P1.C1 x) {... x.M ..
  void g(C2a y) {... y.M ...
}
```

Public members are available evr

The Access Rules: Private

- C1, C2, and C4 are distinct classes.
- Class C2a is either class C2 itself or a subtype of C2.

```
package P1;
public class C1 ... {
  // M is a method, field,...
  private int M ...
  void h(C1 x)
    { ... x.M ... } // OK.
}
-----------------------------
package P1;
public class C4 ... {
  void p(C1 x)
    { ... x.M ... } // ERROR.
}
```

```
package P2;
class C2 extends C1 {
  void f(P1.C1 x) {... x.M ..
  void g(C2a y) {... y.M ...
}
```

Private members are available o
of the same class, even for subty

The Access Rules: Package Private

- C1, C2, and C4 are distinct classes.
- Class C2a is either class C2 itself or a subtype of C2.

```
package P1;
public class C1 ... {
  // M is a method, field,...
  int M ...
  void h(C1 x)
    { ... x.M ... } // OK.
}
-----------------------------
package P1;
public class C4 ... {
  void p(C1 x)
    { ... x.M ... } // OK.
}
```

```
package P2;
class C2 extends C1 {
  void f(P1.C1 x) {... x.M ..
  void g(C2a y) {... y.M ...
}
```

Package Private members are av
the same package (even for subt

The Access Rules: Protected

- C1, C2, and C4 are distinct classes.
- Class C2a is either class C2 itself or a subtype of C2.

```
package P1;
public class C1 ... {
  // M is a method, field,...
  protected int M ...
  void h(C1 x)
    { ... x.M ... } // OK.
}
```

```
package P2;
class C2 extends C1 {
  void f(P1.C1 x) {... x.M ..
       // (x's type is not su
  void g(C2a y) {... y.M ...
  void g2()     {... M ... }
}
```

```
package P1;
public class C4 ... {
  void p(C1 x)
    { ... x.M ... } // OK.
}
```

Protected members of C1 are a
as for package private. Outside
able within subtypes of C1 such
accessed from expressions whos
subtypes of C2.

What May be Controlled

- Classes and interfaces that are not nested may be public or private (we haven't talked explicitly about nested types yet)
- Members—fields, methods, constructors, and (later) nested may have any of the four access levels.
- May *override* a method only with one that has *at least* as per an access level. Reason: avoid inconsistency:

```
package P1;
public class C1 {
  public int f() { ... }
}

public class C2 extends C1 {
  // Actually a compiler error; pretend
  // it's not and see what happens
  int f() { ... }
}
```

```
package P2;
class C3 {
  void g(C2 y2)
    C1 y1 = y2
    y2.f(); //
    y1.f(); //
  }
}
```

That is, there's no point in restricting C2.f, because access depends on static types, and C1.f is public.

Intentions of this Design

- `public` declarations represent *specifications*—what clients o age are supposed to rely on.
- `package private` declarations are part of the *implementat* class that must be known to other classes that assist in th mentation.
- `protected` declarations are part of the implementation th types may need, but that clients of the subtypes generally w
- `private` declarations are part of the implementation of a cl only that class needs.

Quick Quiz

```
package SomePack;
public class A1 {
  int f1() {
    A1 a = ...
    a.x1 = 3; // OK?
  }
  protected int y1;
  private int x1;
}
```

```
// Anonymous package

class A2 {
  void g(SomePack.A1 x) {
    x.f1();  // OK?
    x.y1 = 3; // OK?
  }
}

class B2 extends SomePack.A1
  void h(SomePack.A1 x) {
    x.f1();  // OK?
    x.y1 = 3; // OK?
    f1();     // OK?
    y1 = 3;   // OK?
    x1 = 3;   // OK?
  }
}
```

- **Note:** Last three lines of `h` have implicit **this.**'s in front. Sta of **this** is `B2`.

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    y1 = 3;   // OK
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public class A1 {
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    A1 a = ...
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  }
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  private int x1;
}
```

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// Anonymous package

class A2 {
  void g(SomePack.A1 x) {
    x.f1();  // ERROR
    x.y1 = 3; // ERROR
  }
}

class B2 extends SomePack.A1
  void h(SomePack.A1 x) {
    x.f1();  // ERROR
    x.y1 = 3; // ERROR
    f1();     // ERROR
    y1 = 3;   // OK
    x1 = 3;   // ERROR
  }
}
```

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Access Control Static Only

"Public" and "private" don't apply to dynamic types; it is possibl
methods in objects of types you can't name:

```
package utils;
/** A Set of things. */
public interface Collector {
  void add(Object x);
}
----------------------------
package utils;
public class Utils {
  public static Collector concat() {
    return new Concatenator();
  }
}

/** NON-PUBLIC class that collects strings. */
class Concatenater implements Collector {
  StringBuffer stuff = new StringBuffer();
  int n = 0;
  public void add(Object x) { stuff.append(x); n += 1; }
  public Object value() { return stuff.toString(); }
}
```

```
| package mystuff;
|
| class User {
|    utils.Collector c
|      utils.Utils.con
|
|    c.add("foo");  //
|    ... c.value(); //
|    ((utils.Concatena
|                     /
|
---------------------
```

Loose End #1: Importing

- Writing `java.util.List` every time you mean `List` or `java.lang.regex.Pattern` every time you mean `Pattern` is a
- The purpose of the **import** clause at the beginning of a sourc to define abbreviations:
  - `import java.util.List;` means "within this file, you can as an abbreviation for `java.util.List`.
  - `import java.util.*;` means "within this file, you can class name in the package `java.util` without mentioning th age."
- Importing does *not* grant any special access; it *only* allows a ation.
- In effect, your program always contains `import java.lang`

Loose End #2: Static importing

- One can easily get tired of writing `System.out` and `Math.s` you really need to be reminded with each use that `out` i `java.lang.System` package and that `sqrt` is in the Math (duh)?
- Both examples are of *static* members. New feature of Jav you to abbreviate such references:
  - `import static java.lang.System.out;` means "within t you can use `out` as an abbreviation for `System.out`.
  - `import static java.lang.System.*;` means "within this can use *any* static member name in `System` without mentio package.
- Again, this is *only* an abbreviation. No special access.
- Alas, you can't do this for classes in the anonymous package

Loose End #3: Nesting Classes

- Sometimes, it makes sense to *nest* one class in another. The class might
  - be used only in the implementation of the other, or
  - be conceptually "subservient" to the other
- Nesting such classes can help avoid name clashes or "pollutio name space" with names that will never be used anywhere el
- Example: Polynomials can be thought of as sequences of Terms aren't meaningful outside of Polynomials, so you migh a class to represent a term *inside* the Polynomial class:

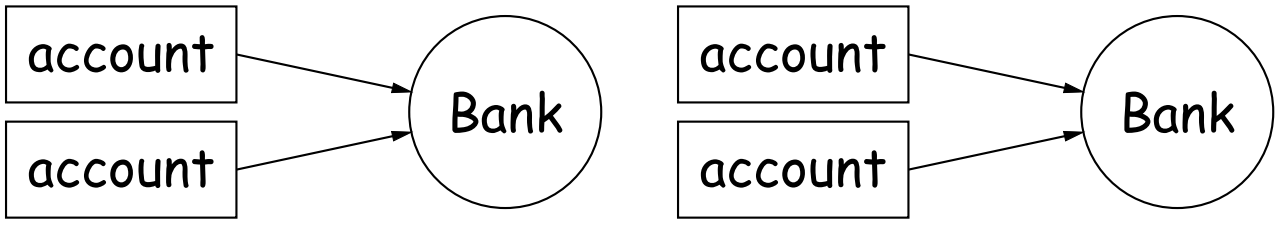
```
class Polynomial {

  methods on polynomials

  private Term[] terms;
  private static class Term {
    ...
  }
}
```

Inner Classes

- Last slide showed a static nested class. Static nested clas
just like any other, except that they can be private or pro
and they can see private variables of the enclosing class.
- Non-static nested classes are called *inner classes.*
- Somewhat rare (and syntax is odd); used when each instanc
nested class is created by and naturally associated with an i
of the containing class, like Banks and Accounts:




```
class Bank {                                  | Bank e = new Bank(..
  private void connectTo(...) {...}           | Bank.Account p0 =
  public class Account {                      |     e.new Account(..
    public void call(int number) {            | Bank.Account p1 =
       Bank.this.connectTo(...); ...          |     e.new Account(..
    } // Bank.this means "the bank that       |
  }   // created me"                          |
}                                             |
```

Loose End #4: instanceof

- It is possible to ask about the dynamic type of something:

```
void typeChecker(Reader r) {
  if (r instanceof TrReader)
    System.out.print("Translated characters: ");
  else
    System.out.print("Characters: ");
  ...
}
```

- However, this is seldom what you want to do. Why do this:

```
if (x instanceof StringReader)
  read from (StringReader) x;
else if (x instanceof FileReader)
  read from (FileReader) x;
...
```

  when you can just call `x.read()`?!

- In general, use instance methods rather than **instanceof**.