Lecture #13: Packages, Access, Etc.

on facilities in Java.

ses.

dden method.

ructors.

.

Package Mechanics

espond to things being modeled (represented) in one's

collections of "related" classes and other packages.

ndard libraries and packages in package `java` and `javax`.

class resides in the *anonymous package*.

ewhere, use a `package` declaration at start of file, as in

```
latabase;      or      package ucb.util;
```

uses convention that class `C` in package `P1.P2` goes in
P1/P2 of any other directory in the *class path*.

e:

```
rt CLASSPATH=.:$HOME/java-utils:$MASTERDIR/lib/classes/junit.jar
 junit.textui.TestRunner MyTests
```

TestRunner.class in ./junit/textui, ~/java-utils/junit/textui
ooks for junit/textui/TestRunner.class in the junit.jar
a single file that is a special compressed archive of an
ory of files).

Access Modifiers

fiers (**private**, **public**, **protected**) do not add anything
of Java.

w a programmer to declare what classes are supposed
ccess ("know about") what declarations.

also part of security—prevent programmers from ac-
s that would "break" the runtime system.

always determined by static types.

ine correctness of writing `x.f()`, look at the definition
e *static type* of `x`.

cause the rules are supposed to be enforced by the
which only knows static types of things (static types
nd on what happens at execution time).

The Access Rules: Public

of a member depends on (1) how the member's decla-
ified and (2) where it is being accessed.

d C4 are distinct classes.

either class C2 itself or a subtype of C2.

```
C1 ... {
ethod, field,...
M ...
)
 ... } // OK.
```

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

```
C4 ... {
)
 ... } // OK.
```

Public members are available everywhere.

The Access Rules: Private

4 are distinct classes.

either class C2 itself or a subtype of C2.

```
C1 ... {
ethod, field,...
 M ...
)
 ... } // OK.
```

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

```
C4 ... {
)
 ... } // ERROR.
```

Private members are available only within the text of the same class, even in subtypes.

he Access Rules: Package Private

4 are distinct classes.

either class C2 itself or a subtype of C2.

```
C1 ... {
ethod, field,...
)
 ... } // OK.
```

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

```
C4 ... {
)
 ... } // OK.
```

Package Private members are available only within the same package (even within subtypes).

What May be Controlled

nterfaces that are not nested may be public or package
aven't talked explicitly about nested types yet).

ields, methods, constructors, and (later) nested types—
of the four access levels.

a method only with one that has *at least* as permissive
el. Reason: avoid inconsistency:

```
;
ss C1 {
nt f() { ... }


ss C2 extends C1 {
lly a compiler error; pretend
ot and see what happens
{ ... }
```

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

e's no point in restricting C2.f, because access control
tatic types, and C1.f is public.

The Access Rules: Protected

4 are distinct classes.

either class C2 itself or a subtype of C2.

```
C1 ... {
ethod, field,...
nt M ...
)
 ... } // OK.

-----------------

C4 ... {
)
 ... } // OK.
```

```
package P2;
class C2 extends C1 {
  void f(P1.C1 x) {... x.M ...} // ERROR
  void g(C2a y) {... y.M ...  } // OK
  void g2()     {... M ... } // OK (this.M)
}
```

Protected members of C1 are available within P1 and within subtypes of C1 such as C2, but only if accessed from objects that have subtypes of C2.

Intentions of this Design

rations represent *specifications*—what clients of a pack-
osed to rely on.

vate declarations are part of the *implementation* of a
ust be known to other classes that assist in the imple-

eclarations are part of the implementation that sub-
ed, but that clients of the subtypes generally won't.

larations are part of the implementation of a class that
ss needs.

Quick Quiz

```
;
{
 OK?

y1;
;
```

```
// 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?
  }
}
```

hree lines of `h` have implicit **this.**'s in front. Static type

Quick Quiz

```
;
{
 OK

y1;
;
```

```
// Anonymous package

class A2 {
  void g(SomePack.A1 x) {
    x.f1();  // ERROR
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  void h(SomePack.A1 x) {
    x.f1();  // OK?
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    f1();     // OK?
    y1 = 3;   // OK?
    x1 = 3;   // OK?
  }
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    f1();     // OK?
    y1 = 3;   // OK?
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  }
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Quick Quiz

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

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

                    class B2 extends SomePack.A1 {
                      void h(SomePack.A1 x) {
                        x.f1();  // ERROR
                        x.y1 = 3; // OK?
                        f1();     // ERROR
                        y1 = 3;   // OK
                        x1 = 3;   // OK?
                      }
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                    class A2 {
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 OK                     x.f1();  // ERROR
                        x.y1 = 3; // ERROR
y1;                   }
;                   }

                    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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;                   // Anonymous package
{
                    class A2 {
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 OK                     x.f1();  // ERROR
                        x.y1 = 3; // ERROR
y1;                   }
;                   }

                    class B2 extends SomePack.A1 {
                      void h(SomePack.A1 x) {
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                        x.y1 = 3; // OK?
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                        y1 = 3;   // OK?
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{
                    class A2 {
                      void g(SomePack.A1 x) {
 OK                     x.f1();  // ERROR
                        x.y1 = 3; // ERROR
y1;                   }
;                   }

                    class B2 extends SomePack.A1 {
                      void h(SomePack.A1 x) {
                        x.f1();  // ERROR
                        x.y1 = 3; // OK?
                        f1();     // ERROR
                        y1 = 3;   // OK?
                        x1 = 3;   // OK?
                      }
                    }
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{
                    class A2 {
                      void g(SomePack.A1 x) {
 OK                     x.f1();  // ERROR
                        x.y1 = 3; // ERROR
y1;                   }
;                   }

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

hree lines of h have implicit **this**.'s in front. Static type

Access Control Static Only

vate" don't apply to dynamic types; it is possible to call
cts of types you can't name:

```
                          | package mystuff;
hings. */                 |
ce Collector {            | class User {
ect x);                   |    utils.Collector c =
                          |      utils.Utils.concat();
--------------            |
                          |    c.add("foo");  // OK
tils {                    |    ... c.value(); // ERROR
c Collector concat() {    |    ((utils.Concatenator) c).value()
 Concatenator();          |                    // ERROR
                          |
                          ----------------------------------

 class that collects strings. */
ater implements Collector {
 stuff = new StringBuffer();

add(Object x) { stuff.append(x); n += 1; }
t value() { return stuff.toString(); }
```


Loose End #1: Importing

.util.List every time you mean List or
egex.Pattern every time you mean Pattern is annoying.

of the **import** clause at the beginning of a source file is
breviations:

ava.util.List; means "within this file, you can use List
reviation for java.util.List.

ava.util.*; means "within this file, you can use *any*
in the package java.util without mentioning the pack-

es not grant any special access; it *only* allows abbrevi-

ur program always contains import java.lang.*;

Loose End #2: Static importing

ly get tired of writing System.out and Math.sqrt. Do
ed to be reminded with each use that out is in the
ystem package and that sqrt is in the Math package

es are of *static* members. New feature of Java allows
viate such references:

tatic java.lang.System.out; means "within this file,
e out as an abbreviation for System.out.

tatic java.lang.System.*; means "within this file, you
y static member name in System without mentioning the

only an abbreviation. No special access.

't do this for classes in the anonymous package.

ose End #3: Parent constructors

tes #5, talked about how Java allows implementer of a
rol all manipulation of objects of that class.

, this means that Java gives the constructor of a class
t at each new object.

ass extends another, there are two constructors—one
nt type and one for the new (child) type.

Java guarantees that one of the parent's constructors
t. In effect, there is a call to a parent constructor at
g of every one of the child's constructors.

he parent's constructor yourself. By default, Java calls
" (parameterless) constructor.

```
re {                      class Rectangle extends Figure {
igure(int sides) {           public Rectangle() {
                                 super(4);
                             }...
                          }
```


End #4: Using an Overridden Method

you wish to *add* to the action defined by a superclass's
er than to completely override it.

ng method can refer to overridden methods by using
refix super.

, you have a class with expensive functions, and you'd
zing version of the class.

```
uteHard {
tate(String x, int y) { ... }


uteLazily extends ComputeHard {
tate(String x, int y) {
n't already have answer for this x and y) {
 result = super.cogitate(x, y);  // <<< Calls overridden function
noize (save) result;
rn result;

 memoized result;
```


Loose End #5: Nesting Classes

t makes sense to *nest* one class in another. The nested

nly in the implementation of the other, or
tually "subservient" to the other

classes can help avoid name clashes or "pollution of the
with names that will never be used anywhere else.

lynomials can be thought of as sequences of terms.
meaningful outside of Polynomials, so you might define
present a term *inside* the Polynomial class:

```
nomial {

on polynomials

Term[] terms;
static class Term {
```

Trick: Delegation and Wrappers

ppropriate to use inheritance to extend something.

ives example of a `TrReader`, which *contains* another which it *delegates* the task of actually going out and acters.

mple: a class that *instruments* objects:

```
e {
t x);
```

```
class Monitor implements Storage {
  int gets, puts;
  private Storage store;
  Monitor(Storage x) { store = x; gets = puts = 0; }
  public void put(Object x) { puts += 1; store.put(x); }
  public Object get() { gets += 1; return store.get(); }
}
```

```
thing;
```

```
// INSTRUMENTED
Monitor S = new Monitor(something);
f(S);
System.out.println(S.gets + " gets");
```

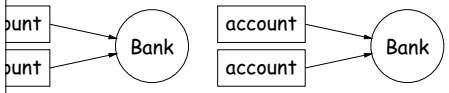
led a *wrapper class*.

Inner Classes

owed a static nested class. Static nested classes are other, except that they can be private or protected, see private variables of the enclosing class.

ested classes are called *inner classes*.

re (and syntax is odd); used when each instance of the is created by and naturally associated with an instance ining class, like Banks and Accounts:




```
d connectTo(...) {...}
s Account {
id call(int number) {
his.connectTo(...); ...
.this means "the bank that
ted me"
```

```
| Bank e = new Bank(...);
| Bank.Account p0 =
|     e.new Account(...);
| Bank.Account p1 =
|     e.new Account(...);
|
|
|
```


Loose End #6: instanceof

to ask about the dynamic type of something:

```
ker(Reader r) {
nceof TrReader)
t.print("Translated characters: ");

t.print("Characters: ");
```

s is *seldom* what you want to do. Why do this:

```
eof StringReader)
StringReader) x;
stanceof FileReader)
FileReader) x;
```

just call `x.read()`?!

se instance methods rather than **instanceof**.