cture #8: Object-Oriented Mechanisms

lecture: the bare mechanics of "object-oriented pro-

topic is: Writing software that operates on many kinds

Overloading

to get System.out.print(x) to print x, regardless of

r Python, one function can take an argument of any type,
t the type (if needed).

hods specify a single type of argument.

ion: *overloading*—multiple method definitions with the
nd different numbers or types of arguments.

out has type java.io.PrintStream, which defines

```
n()  Prints new line.
n(String s)  Prints S.
n(boolean b)  Prints "true" or "false"
n(char c)  Prints single character
n(int i)  Prints I in decimal
```

e is a different function. Compiler decides which to call
of arguments' types.

Generic Data Structures

to get a "list of anything" or "array of anything"?

blem in Scheme or Python.

lists (such as IntList) and arrays have a single type of

hort answer: any *reference* value can be converted to
ang.Object and back, so can use Object as the "generic
type":

```
ings = new Object[2];
 new IntList(3, null);
 "Stuff";
tList) things[0]).head == 3;
ring) things[1]).startsWith("St") is true
].head             Illegal
].startsWith("St")  Illegal
```


And Primitive Values?

ues (ints, longs, bytes, shorts, floats, doubles, chars,
) are not really convertible to Object.

roblem for "list of anything."

oduced a set of *wrapper types*, one for each primitive

ef.	Prim.	Ref.	Prim.	Ref.
yte	short	Short	int	Integer
ong	char	Character	boolean	Boolean
oat	double	Double		

ate new wrapper objects for any value (*boxing*):

```
hree = new Integer(3);
reeObj = Three;
```

sa (*unboxing*):

```
 = Three.intValue();
```


Autoboxing

ons, boxing and unboxing is automatic (in many cases):

```
ee = 3;
 Three;
hree + 3;

omeInts = { 1, 2, 3 };
 someInts) {
out.println(x);


println(someInts[0]);  // Prints 3, but NOT unboxed.
```

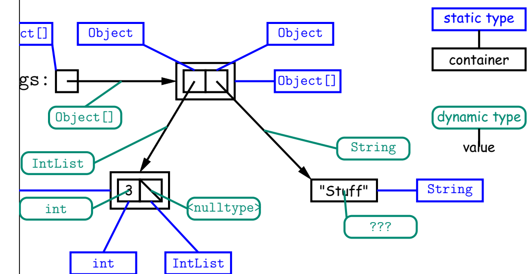

Dynamic vs. Static Types

has a type—its *dynamic type*.

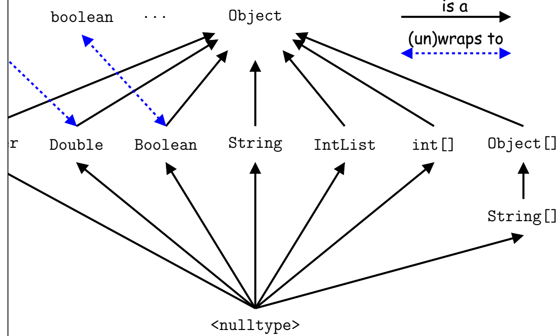
iner (variable, component, parameter), literal, function
rator expression (e.g. x+y) has a type—its *static type*.

every *expression* has a static type.

```
gs = new Object[2];
ew IntList(3, null);
Stuff";
```



a Library Type Hierarchy (Partial)



Coercions

f type `short`, for example, are a subset of those of
are representable as 16-bit integers, `int`s as 32-bit

say that `short` is a subtype of `int`, because they don't
the same.

say that values of type `short` can be *coerced* (con-
value of type `int`.

ight fudge: compiler will silently coerce "smaller" inte-
larger ones, `float` to `double`, and (as just seen) be-
ive types and their wrapper types.

```
002;
```

it complaint.

Overriding and Extension

far is clumsy.

`Object` variable `x` contains a `String`, why can't I write,
`h("this")`?

`th` is only defined on `String`s, not on all `Object`s, so the
t sure it makes sense, unless you cast.

eration *were* defined on all `Object`s, then you *wouldn't*
casting.

`oString()` is defined on all `Object`s. You can always say
`)` if `x` has a reference type.

`.toString()` function is not very useful; on an `IntList`,
e string like `"IntList@2f6684"`

subtype of Object, you may *override* the default defi-

Type Hierarchies

with (static) type T may contain a certain value only if
s a" T—that is, if the (dynamic) type of the value is a
T. Likewise, a function with return type T may return
hat are subtypes of T.

subtypes of themselves (& that's all for primitive types)

ypes form a *type hierarchy;* some are subtypes of oth-
pe is a subtype of all reference types.

e types are subtypes of `Object`.

The Basic Static Type Rule

gned so that any expression of (static) type T always
that "is a" T.

are "known to the compiler," because you declare them,

```
          // Static type of field
t s)  { // Static type of call to f, and of parameter
          // Static type of local variable
```

pre-declared by the language (like 3).

sts that in an *assignment*, `L = E`, or function call, `f(E)`,

```
SomeType L) { ... },
```

pe must be subtype of L's static type.

apply to `E[i]` (static type of E must be an array) and
n operations.

quences of Compiler's "Sanity Checks"

servative rule. The last line of the following, which you
s perfectly sensible, is illegal:

```
ew int[2];
A; // All references are Objects
   // Static type of A is array...
   // But not of x: ERROR
```

ures that not every `Object` is an array.

know that `x` contains array value!?

till must tell the compiler, like this:

```
) x)[i+1] = 1;
```

type of cast `(T) E` is T.

isn't an array value, or is null?

ve have runtime errors—exceptions.

Extending a Class

class B is a direct subtype of class A (or A is a direct
f B), write

```
 extends A { ... }
```

lass ... extends java.lang.Object.

inherits all fields and methods of its *superclass* (and
along to any of its subtypes).

u may *override* an instance method (*not* a static method),
a new definition with same *signature* (name, return
nt types).

a method and all its overridings form a *dynamic method*

f f(...) is an instance method, then the call x.f(...)
r overriding of f applies to the *dynamic type* of x, re-
the static type of x.

t About Fields and Static Methods?

```
                              class Child extends Parent {
                                String x = "no";
 1;                             static String y = "way";
) {                             static void f() {
printf("Ahem!%n");                System.out.printf("I wanna!%n");
                                }
nt x) {                       }
```

```
ew Child();  | tom.x    ==> no       pTom.x    ==> 0
tom;         | tom.y    ==> way      pTom.y    ==> 1
             | tom.f()  ==> I wanna! pTom.f()  ==> Ahem!
             | tom.f(1) ==> 2        pTom.f(1) ==> 2
```

hide inherited fields of same name; static methods
f the same signature.
ding causes confusion; so understand it, but don't do it!

Overriding toString

, if s is a String, s.toString() is the identity function
).

you define, you may supply your own definition. For
ntList, could add

```
ng toString() {
uffer b = new StringBuffer();
d("[");
tList L = this; L != null; L = L.tail)
ppend(" " + L.head);
d("]");
b.toString();
```

IntList(3, new IntList(4, null)), then x.toString()

, the "+" operator on Strings calls .toString when asked
Object, and so does the "%s" formatter for printf.

ick, you can supply an output function for any type you

Illustration

```
class Worker {
  void work() {
    collectPay();
  }
}
```

```
ds Worker {       | class TA extends Worker {
rk()              |   void work() {
                  |     while (true) {
                  |       doLab(); discuss(); officeHour();
                  |     }
                  |   }
                  | }
```

```
Prof();     | paul.work()  ==> collectPay();
TA();       | daniel.work()  ==> doLab(); discuss(); ...
aul,        | wPaul.work() ==> collectPay();
 daniel;    | wDaniel.work() ==> doLab(); discuss(); ...
```

stance methods (only), select method based on *dynamic*
state, but we'll see it has profound consequences.

What's the Point?

sm described here allows us to define a kind of *generic*

can define a set of operations (methods) that are com-
different classes.

can then provide different implementations of these
hods, each specialized in some way.

s will have at least the methods listed by the super-

write methods that operate on the superclass, they will
work for all subclasses with no extra work.