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
ng	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

xing are automatic (in many cases):

```
e = 3;
 Three;
ree + 3;

meInts = { 1, 2, 3 };
 someInts) {
ut.println(x);


println(someInts[0]);
s Integer 1, but NOT unboxed.
```

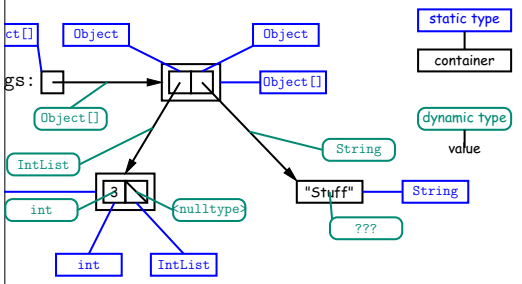

Dynamic vs. Static Types

has a type—its *dynamic type.*

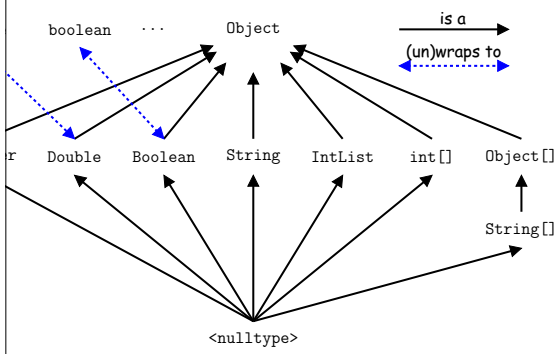
ner (variable, component, parameter), literal, function
rator expression (e.g. `x+y`) has a type—its *static type.*

very *expression* has a static type.

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



a Library Type Hierarchy (Partial)



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-
be is a subtype of all reference types.

e types are subtypes of `Object`.

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;
```

ut complaint.

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
```

re-declared by the language (like 3).

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

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

e must be subtype of L's static type.

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

Overriding and Extension

far is clumsy.

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

th is only defined on Strings, 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.

`String()` 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-

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 direct superclass hem 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(...)` er overriding of `f` applies to the *dynamic type* of `x`, re- he static type of `x`.

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 {
rk()
```

```
class TA extends Worker {
  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.

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!

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.

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

es 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.