Ad-hoc Polymorphism

Ad-hoc[1] polymorphism in Java occurs when a method or operator is applicable to different types. We look at three kinds of ad-hoc polymorphism: (1) overloading of methods, (2) overloading of operator +, and (3) autoboxing / unboxing.

Overloading names

Class `Math` in package `java.lang` has lots of functions for performing basic numeric operations. You will no doubt use class `Math` often. Four of its functions are shown to the right. They calculate the absolute value of a **double** value, a **float** value, an **int** value, and a **long** value.

```
/** = the absolute value of b. */
static double abs(double b)

/** = the absolute value of b. */
static float abs(float b)

/** = the absolute value of b. */
static int abs(int b)

/** = the absolute value of b. */
static long abs(long b)
```

All four functions are named `abs`! In certain circumstances, several methods can have the same name. This is called *overloading*.

This is an example of polymorphism: function `abs` calculates an absolute value, and it comes in four forms. Remember, polymorphism is the capability of assuming different forms.

It's good that overloading is allowed in Java. If not, we would have to have four different names for the four `abs` methods. That could get messier as we write larger programs with many similar methods.

When there is a method call like `Math.abs(-5)` in a program, the argument, `-5`, is used to determine which function to call. Since `-5` has type **int**, the function with an **int** parameter will be called.

You may wonder whether *you* can overload method names in your programs. Yes, of course! We illustrate this with class `Counter` to the right, which you might have written. An instance of `Counter` maintains a counter. The counter is initially 0, and it can be incremented with a call on procedure `increment`.

```
/** An instance maintains a counter,
    which is initially 0. */
class Counter {
  private int ctr; // the counter

  /** = the value of the counter */
  public int ctr() { return ctr; }

  /** increment the counter */
  public void increment()
      { ctr= ctr + 1; }

  /** reset the counter to 0 */
  public void reset() { ctr= 0; }

  /** reset the counter to i */
  public void reset(int i) { ctr= i; }
}
```

There are two `reset` procedures. One sets the counter to 0, the other sets the counter to its parameter `i`. The name `reset` is overloaded. Both procedures reset the counter, but they have different forms. That is polymorphism.

Class `Counter` illustrates another form of polymorphism and overloading. The name `ctr` takes two forms: a variable and a method. The field name is `ctr`, and method `ctr` () returns the value of field `ctr`. In Java, a variable and method can have the same name.

Note that *overloading* and *overriding* are different. Look up *overriding* in JavaHyperText.

Overloading operators

Another form of overloading is *operator overloading*. The operator + has several meanings: addition and catenation. For example,

The value of 2 + 3 is 5; operator + stands for **int** addition.

The value of 2.0 + 3 is 5.0; operator + stands for **double** addition since 2.0 is a **double**, the 3 an **int**.

The value of "2" + 3 is "23"; since at least one operand is a String, + stands for string catenation.

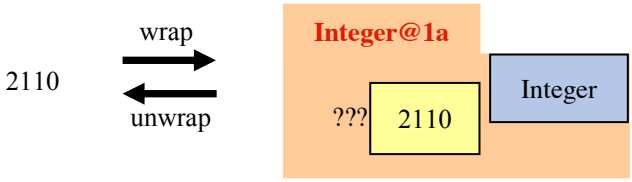
The programming language Python allows the programmer to overload operators like + and – and * with other meanings. Java, however, does not allow this.

[1] "ad hoc": for the particular end or case at hand without consideration of wider application [Merriam-Webster]

Autoboxing/unboxing

If you are unfamiliar with the notion of a wrapper class, before reading further, read the one-page pdf file under entry *wrapper* in JavaHyperText.

Primitive type values are not objects, so **int** value 2110 is not an object. However, there are places in a Java program where one would like to have an **int** value but only an object can appear. Therefore, Java has wrapper class `Integer`, each object of which wraps an **int** value. Thus, as shown below, an integer comes in two forms: as a primitive value and as a primitive value wrapped in an `Integer` object. That's polymorphism.



If an integer like 2110 appears in a place where an object is required, Java will *automatically* wrap it in an `Integer` object. It will also automatically unwrap it.

Java calls these two coercions *autoboxing* and *auto-unboxing* instead of auto-wrapping and auto-unwrapping. We give examples: autoboxing will happen in the first assignment to the right and auto-unboxing in the second one.

```
Integer k= 2110;
int h= k;
```

You can write your own code to wrap and unwrap primitive values. As an example, the call shown to the right returns a pointer to an `Integer` object that wraps the integer 2110.[2] In the second example shown to the right, first, 2110 is wrapped and the pointer to the object is stored in `k`; then the following method call returns the **int** value that is in object `k`.

```
Integer.valueOf(2110);

Integer k= Integer.valueOf(2110);
k.intValue()
```

Summary

We have discussed three kinds of ad-hoc polymorphism:

- Method name overloading: a method has "many forms". For each call, the types of the arguments are used to distinguish which form of the method to call.
- Operator overloading: + can be **int** addition, **long** addition, **double** addition, **float** addition, or String catenation. The types of the operands in an expression `op1 + op2` determine which it is.
- Autoboxing: A primitive value has two forms: the value itself and the value wrapped in an object. Java automatically wraps and unwraps it for you where the need arises.

Note that this kind of polymorphism is a compile-time feature, a syntactic feature, not a runtime feature. For example,

- the compiler will look at a call of an overloaded method and determine which form of the method to call.
- The compiler will determine what kind of an operator an occurrence of + is, based on the types of its operands.
- The compiler will insert autoboxing or auto-unboxing operations where necessary.

The ad-hoc polymorphism features greatly simplify programming.

---

[2] There is a constructor for class `Integer`, but it has been deprecated —it is preferable not to use it. The Java API documentation for the wrapper classes say to use instead of the constructor the static function `valueOf` (e.g. `Integer.valueOf` (3), `Boolean.valueOf` (**true**)) because `valueOf` is likely to yield significantly better time and space performance than the constructor.