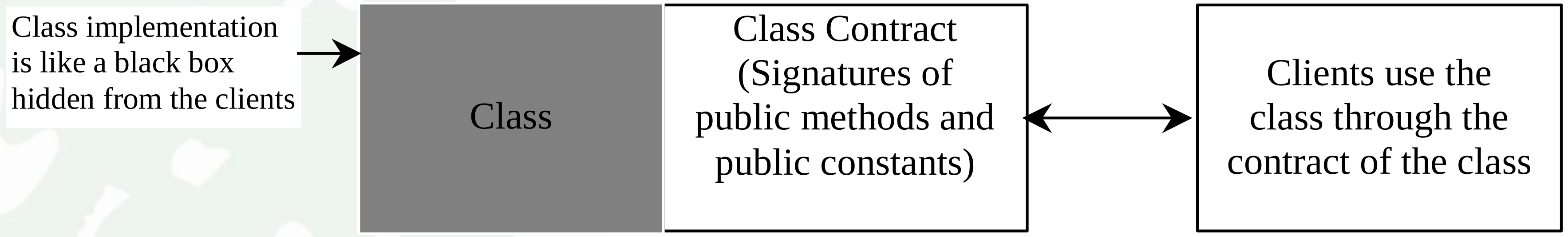
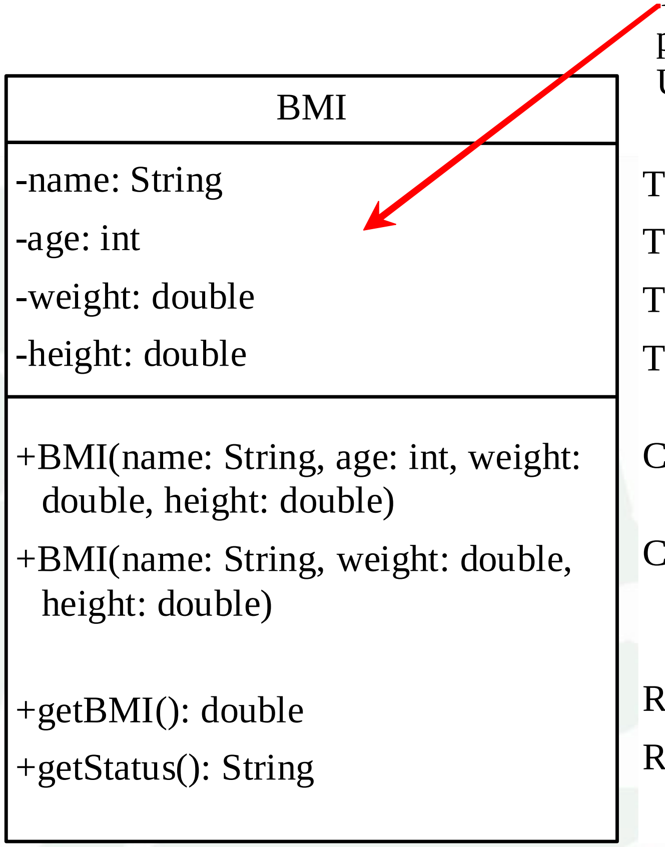
Chapter 10 Thinking in Objects

Class Abstraction and Encapsulation

Class abstraction means to separate class implementation from the use of the class. The creator of the class provides a description of the class and let the user know how the class can be used. The user of the class does not need to know how the class is implemented. The detail of implementation is encapsulated and hidden from the user.


Class implementation is like a black box hidden from the clients
Class
Class Contract (Signatures of public methods and public constants)
Clients use the class through the contract of the class

The BMI Class


BMI
-name: String
-age: int
-weight: double
-height: double
+BMI(name: String, age: int, weight: double, height: double)
+BMI(name: String, weight: double, height: double)
+getBMI(): double
+getStatus(): String

The get methods for these data fields are provided in the class, but omitted in the UML diagram for brevity.

The name of the person.

The age of the person.

The weight of the person in pounds.

The height of the person in inches.

Creates a BMI object with the specified name, age, weight, and height.

Creates a BMI object with the specified name, weight, height, and a default age 20.

Returns the BMI

Returns the BMI status (e.g., normal, overweight, etc.)

BMI UseBMIClass Run

Class Relationships

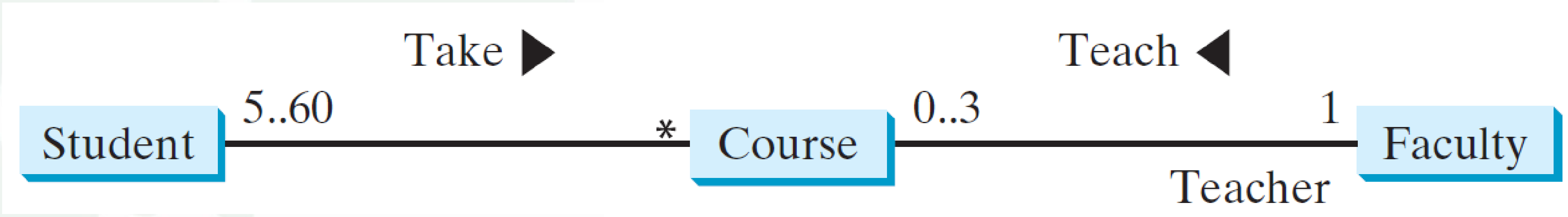
Association

Aggregation

Composition

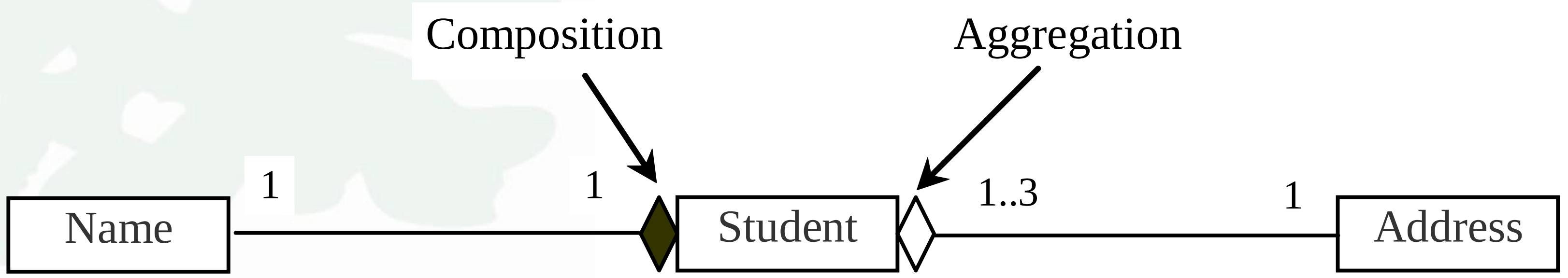
Inheritance (Chapter 13)

Association: is a general binary relationship that describes an activity between two classes.



Object Composition

Composition is actually a special case of the aggregation relationship. Aggregation models *has-a* relationships and represents an ownership relationship between two objects. The owner object is called an *aggregating object* and its class an *aggregating class*. The subject object is called an *aggregated object* and its class an *aggregated class*.



Class Representation

An aggregation relationship is usually represented as a data field in the aggregating class. For example, the relationship in Figure 10.6 can be represented as follows:

```
public class Name {
  ...
}
```

Aggregated class

```
public class Student {
  private Name name;
  private Address address;

  ...
}
```

Aggregating class

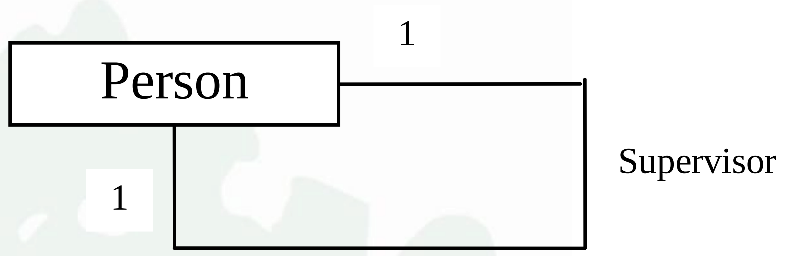
```
public class Address {
  ...
}
```

Aggregated class

Since aggregation and composition relationships are represented using classes in similar ways, many texts don't differentiate them and call both compositions.

Aggregation Between Same Class

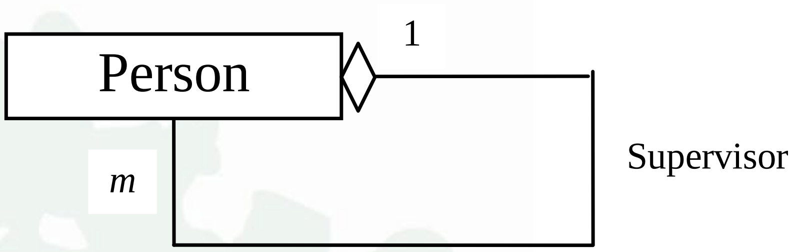
Aggregation may exist between objects of the same class. For example, a person may have a supervisor.



```
public class Person {
  // The type for the data is the class itself
  private Person supervisor;
  ...
}
```

Aggregation Between Same Class

What happens if a person has several supervisors?



```
public class Person {
  ...
  private Person[] supervisors;
}
```

Example: The Course Class

Course	
`-courseName: String`	The name of the course.
`-students: String[]`	An array to store the students for the course.
`-numberOfStudents: int`	The number of students (default: 0).
`+Course(courseName: String)`	Creates a course with the specified name.
`+getCourseName(): String`	Returns the course name.
`+addStudent(student: String): void`	Adds a new student to the course.
`+dropStudent(student: String): void`	Drops a student from the course.
`+getStudents(): String[]`	Returns the students in the course.
`+getNumberOfStudents(): int`	Returns the number of students in the course.

Course TestCourse Run

Wrapper Classes

- Boolean
- Character
- Short
- Byte
- Integer
- Long
- Float
- Double

NOTE: (1) The wrapper classes do not have no-arg constructors. (2) The instances of all wrapper classes are immutable, i.e., their internal values cannot be changed once the objects are created.

The `Integer` and `Double` Classes

java.lang.Integer

```
-value: int
+MAX_VALUE: int
+MIN_VALUE: int

+Integer(value: int)
+Integer(s: String)
+byteValue(): byte
+shortValue(): short
+intValue(): int
+longVlaue(): long
+floatValue(): float
+doubleValue():double
+compareTo(o: Integer): int
+toString(): String
+valueOf(s: String): Integer
+valueOf(s: String, radix: int): Integer
+parseInt(s: String): int
+parseInt(s: String, radix: int): int
```

java.lang.Double

```
-value: double
+MAX_VALUE: double
+MIN_VALUE: double

+Double(value: double)
+Double(s: String)
+byteValue(): byte
+shortValue(): short
+intValue(): int
+longVlaue(): long
+floatValue(): float
+doubleValue():double
+compareTo(o: Double): int
+toString(): String
+valueOf(s: String): Double
+valueOf(s: String, radix: int): Double
+parseDouble(s: String): double
+parseDouble(s: String, radix: int): double
```

The `Integer` Class and the `Double` Class

- Constructors
- Class Constants `MAX_VALUE`, `MIN_VALUE`
- Conversion Methods

Numeric Wrapper Class Constructors

You can construct a wrapper object either from a primitive data type value or from a string representing the numeric value. The constructors for Integer and Double are:

```
public Integer(int value)

public Integer(String s)

public Double(double value)

public Double(String s)
```

Numeric Wrapper Class Constants

Each numerical wrapper class has the constants MAX_VALUE and MIN_VALUE. MAX_VALUE represents the maximum value of the corresponding primitive data type. For Byte, Short, Integer, and Long, MIN_VALUE represents the minimum byte, short, int, and long values. For Float and Double, MIN_VALUE represents the minimum *positive* float and double values. The following statements display the maximum integer (2,147,483,647), the minimum positive float (1.4E-45), and the maximum double floating-point number (1.79769313486231570e+308d).

Conversion Methods

Each numeric wrapper class implements the abstract methods doubleValue, floatValue, intValue, longValue, and shortValue, which are defined in the Number class. These methods “convert” objects into primitive type values.

The Static valueOf Methods

The numeric wrapper classes have a useful class method, valueOf(String s). This method creates a new object initialized to the value represented by the specified string. For example:

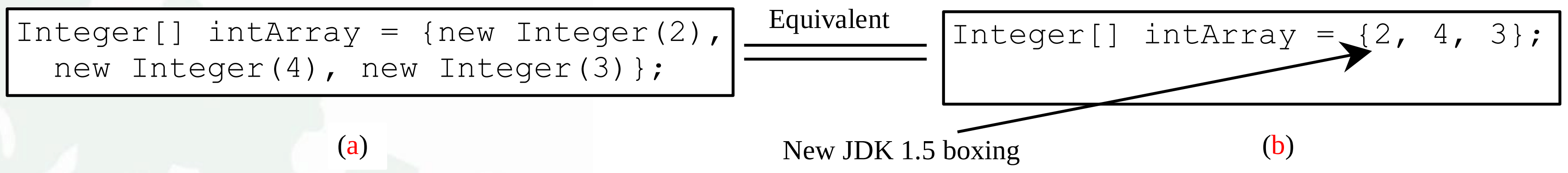
```
Double doubleObject = Double.valueOf("12.4");

Integer integerObject = Integer.valueOf("12");
```

The Methods for Parsing Strings into Numbers

You have used the parseInt method in the Integer class to parse a numeric string into an int value and the parseDouble method in the Double class to parse a numeric string into a double value. Each numeric wrapper class has two overloaded parsing methods to parse a numeric string into an appropriate numeric value.

Automatic Conversion Between Primitive Types and Wrapper Class Types

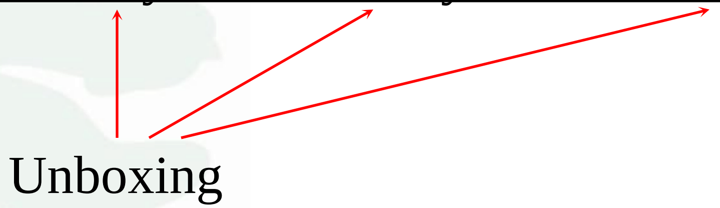
JDK 1.5 allows primitive type and wrapper classes to be converted automatically. For example, the following statement in (a) can be simplified as in (b):



```
Integer[] intArray = {new Integer(2),
  new Integer(4), new Integer(3)};
```

```
Integer[] intArray = {2, 4, 3};
```

Integer[] intArray = {1, 2, 3};
System.out.println(intArray[0] + intArray[1] + intArray[2]);



BigInteger and BigDecimal

If you need to compute with very large integers or high precision floating-point values, you can use the BigInteger and BigDecimal classes in the java.math package. Both are *immutable*. Both extend the Number class and implement the Comparable interface.

BigInteger and BigDecimal

```
BigInteger a = new BigInteger("9223372036854775807");
BigInteger b = new BigInteger("2");
BigInteger c = a.multiply(b); // 9223372036854775807 * 2
System.out.println(c);
```

LargeFactorial Run

```
BigDecimal a = new BigDecimal(1.0);
BigDecimal b = new BigDecimal(3);
BigDecimal c = a.divide(b, 20, BigDecimal.ROUND_UP);
System.out.println(c);
```

abs()	It returns a BigInteger whose value is the absolute value of this BigInteger.
add()	This method returns a BigInteger by simply computing 'this + val' value.
compareTo()	This method compares this BigInteger with the specified BigInteger.
divide()	This method returns a BigInteger by computing 'this /~val ' value.
divideAndRemainder()	This method returns a BigInteger by computing 'this & ~val ' value followed by 'this%value'.
doubleValue()	This method converts this BigInteger to double.
equals()	This method compares this BigInteger with the given Object for equality.
gcd()	This method returns a BigInteger whose value is the greatest common divisor between abs(this)and abs(val).
floatValue()	This method converts this BigInteger to float.
intValue()	This method converts this BigInteger to an int.
longValue()	This method coverts this BigInteger to a long.
max()	This method returns the maximum between this BigInteger and val.
min()	This method returns the minimum between this BigInteger and val.
mod()	This method returns a BigInteger value for this mod m.
multiply()	This method returns a BigInteger by computing 'this *val ' value.
negate()	This method returns a BigInteger whose value is '-this'.
pow()	This method returns a BigInteger whose value is 'this^{exponent}'.
remainder()	This method returns a BigInteger whose value is 'this % val'.
signum()	This method returns the signum function of this BigInteger.
subtract()	This method returns a BigInteger whose value is 'this - val'.
toString()	This method returns the decimal String representation of this BigInteger.
valueOf()	This method returns a BigInteger whose value is equivalent to that of the specified long.