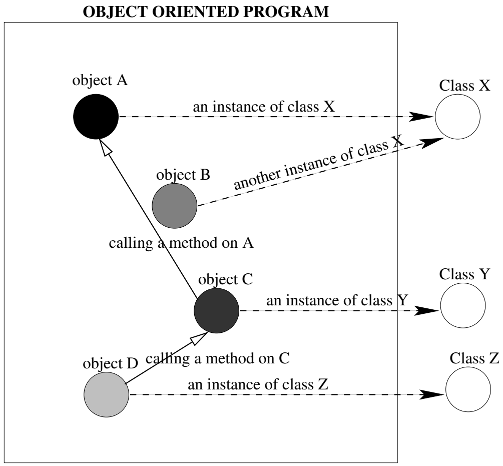
5COSC001W - OBJECT ORIENTED PROGRAMMING
Lecture 2: More on Classes

Dr Dimitris C. Dracopoulos


OBJECT ORIENTED PROGRAM
object A
an instance of class X
Class X
object B
another instance of class X
calling a method on A
object C
an instance of class Y
Class Y
object D
calling a method on C
an instance of class Z
Class Z

Constructing Objects

Objects of a class are created by calling the *constructor* of the class with the `new` operator.

- Constructors are methods of the class and they always have the same name with the class itself.
- A class can have more than one constructors. Each one of them must have a different number (and/or type) of parameters.

Syntax:

```
new ClassName(parameters)
```

Constructor Example: The Rectangle Library class

The `Rectangle` class is defined in the library (package `java.awt`).

- A `Rectangle` object contains a set of numbers specifying an area in a coordinate space by its top-left point (x, y), its width, and its height.

```
Rectangle r1 = new Rectangle(5, 10, 20, 30);
```

1. The constructor of the `Rectangle` class accepting four `int`s as parameters is called, to create a `Rectangle` object.
2. The created object has a top left corner at $(5, 10)$ and has a width equal to 20 and a height equal to 30.
3. The created object is returned and it is stored (its address) in variable `r1`.

An alternative constructor of the `Rectangle` class could be called to create an object:

```
Rectangle r2 = new Rectangle();
```

The no-arguments constructor, creates a `Rectangle` object whose top-left corner is at (0, 0) in the coordinate space, and whose width and height are both zero

Packages

Classes (including library classes) belong to a *package*. Thus, a package is a collection of classes.

- To be able to use a class belonging to a package in a program, the class must first be imported in the program. There are two ways to do that:
    1. Import all the classes of the package into the program, e.g.

       ```
       import java.awt.*;
       ```

    2. Import only the class that needs to be used, e.g.

       ```
       import java.awt.Rectangle;
       ```

Example

```java
import java.awt.Rectangle;

public class MoveTester {
   public static void main(String[] args) {
      Rectangle box = new Rectangle(5, 10, 20, 30);

      // Move the rectangle
      box.translate(15, 25);

      // Print information about the moved rectangle
      System.out.println("After moving, the top-left corner is:");
      System.out.println(box.getX() + ", " + box.getY());
   }
}
```

Implementing Classes

Implement a class which simulates a bank account. The following operations must be available (abstraction):

- Deposit money.
- Withdraw money.
- Get the current balance.

```
/**
   A bank account has a balance that can be changed by
   deposits and withdrawals.
*/
public class BankAccount {
    private double balance;

    /**
        Constructs a bank account with a zero balance.
    */
    public BankAccount()
    {
        balance = 0;
    }



    /**
        Constructs a bank account with a given balance.
        @param initialBalance the initial balance
    */
    public BankAccount(double initialBalance)
    {
        balance = initialBalance;
    }
```

```
/**
    Deposits money into the bank account.
    @param amount the amount to deposit
*/
public void deposit(double amount)
{
    double newBalance = balance + amount;
    balance = newBalance;
}

/**
    Withdraws money from the bank account.
    @param amount the amount to withdraw
*/
public void withdraw(double amount)
{
    double newBalance = balance - amount;
    balance = newBalance;
}

/**
    Gets the current balance of the bank account.
    @return the current balance
*/
public double getBalance()
{
    return balance;
}
```

Testing a Class

```
/**
   A class to test the BankAccount class.
*/
public class BankAccountTester {
    /**
        Tests the methods of the BankAccount class.
    */
    public static void main(String[] args) {
        BankAccount harrysChecking = new BankAccount();
        harrysChecking.deposit(2000);
        harrysChecking.withdraw(500);
        System.out.println(harrysChecking.getBalance());

        BankAccount harrysSavings = new BankAccount(100);
        harrysSavings.withdraw(30);
        harrysSavings.withdraw(10);
        harrysSavings.deposit(20);
        double balance = harrysSavings.getBalance();
        System.out.println("Savings account balance: " + balance);
    }
}
```

When the above program is run, it displays: v

```
1500.0
Savings account balance: 80.0
```

Overloading Methods

A class can have more than one methods with the same name, assuming that these methods have a different signature.

- The signature of a method consists of the combination of its name and its arguments (the specific order, number and type of arguments)

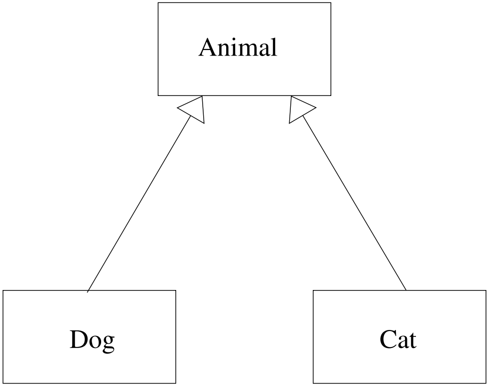
Example

```
public class Printer {
   int errorCode;

   // constructor 1
   public Printer() {
      System.out.println("Constructor with no arguments called!");
   }

   // constructor 2
   public Printer(int i) {
      errorCode = i;
      System.out.println("Constructor with an int argument called!
   }

   public void display() {
      System.out.println(errorCode);
   }

   public void display(int i) {
      System.out.println(i);
   }

   public void display(String s) {
      System.out.println(s);
   }
   public void display(int i, String s) {
      System.out.println(i + s);
   }

   public void display(String s, int i) {
      System.out.println(i + s);
   }
}
```

Inheritance

Hierarchies of class can be created for the following reasons:

- Reusability of code (Reusability of the functionality of existing classes).
- Code is easier to maintain.
- Polymorphic behaviour (objects are manipulated via reference variables of the base class).



Example:

```java
class Person {
    private String name;

    public Person() {

    }

    public Person(String name1) {
        name = name1;
    }

    // initialise the name instance field of the object
    public void setName(String name) {
        /* this is a shortcut for the object we are currently in.
           Thus, this.name is the instance field name within the
           current object */
        this.name = name;
    }

    // prints all information about the object
    public void info() {
        System.out.println("\nname: " + name);
    }
}
```

```
class Student extends Person {
    private String school;

    public Student(String school, String name) {
        this.school = school;
        setName(name);
    }

    // prints all information about the object
    public void info() {
        // call info() method of Person class
        super.info();
        System.out.println("school: " + school);
    }
}

class PostGraduateStudent extends Student {
    private String firstDegree;  // what the first degree was on \

    public PostGraduateStudent(String school, String name,
                               String degree) {
        super(school, name);  // call constructor of parent class
        firstDegree = degree; }

    public void info() {
        super.info();
        System.out.println("firstDegree: " + firstDegree);
    }
```

```java
public class University {
   public static void main(String[] args) {
      Student s1 = new Student("IC", "John");
      Student s2 = new Student("MIT", "Helen");
      PostGraduateStudent s3 = new PostGraduateStudent(
                                             "Westminster",
                                             "George",
                                             "music");

      s1.info();
      s2.info();
      s3.info();
   }
}
```

When the above program is run, it displays:

```
name: John
school: IC

name: Helen
school: MIT

name: George
school: Westminster
firstDegree: music
```

Overriding Methods

When a class defines a method with the same signature as a method in a parent class, the method is overridden in the subclass.

- `Student` overrides the `info` method with its own implementation (initially it inherits the `Person` version of `info`.
- `PostGraduateStudent` overrides the `info` method with its own implementation (initially it inherits the `Student` version of `info`).

The super keyword

The super keyword can be used for three purposes:

- To call a constructor of the parent class. In such a case, the super call must be the first statement in the constructor of the subclass:

  ```
  public PostGraduateStudent(String school, String name, String
          super(school, name);
          firstDegree = degree;
      }
  ```

  The first line in the above constructor calls the constructor `Student(String, String)` of the parent class.
- To call any method of the parent class, even if that method is overridden in the current class.
- To access a field of the parent class. For example, `super.x` in class `B` accesses the `A` instance field `x`:

```
class A {
    public int x;
}

class B extends A {
    public int x;

    void foo() {
        int y = super.x;  // accesses x within A, NOT x in B!
    }
}
```