Lecture 2: Java & Javadoc

CS 62

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Alexandra Papoutsaki & William Devanny

Instance Variables

- or member variables or fields
- Declared in a class, but outside of any method, constructor or block
- Each object has its own copy of the variable!
- Invoked as: **`myObject.variableName`**

Static Variables

- or class variables
- static means constant, i.e. it will be constant for all instances of the class
- cannot be defined in method body
- Invoked as: **`myClass.variableName`**

Local Variables

- Declared in method, constructor or block
- Destroyed after the execution of the method
- **No** access modifier

Methods

- A collection of grouped statements that perform a logical operation and control the behavior of objects
- Syntax:
  - modifier return-type method-name(type parameter-name,…){…}
  - e.g., `public int enrollInClass(int classID){…}`
  - *Signature:* method name and the number, type, and order of its parameters. Not return type
- Can also be `static`, therefore shared by all instances of a class
- Can be *overloaded* (same name, different parameters)

this

- Within an instance method or a constructor used to refer to current object
  - can be used to call instance variables, methods, and constructors

```
public class Car{
    private String color;

    public Car(){
        this(“undefined”);
    }
    public Car(String color){
        this.color = color;
    }
```

Combination of variables and methods

- Instance methods can access instance variables and instance methods directly.
- Instance methods can access static variables and static methods directly.
- Static methods can access static variables and static methods directly.
- Static methods ***cannot*** access instance variables or instance methods directly—they must use an object reference.
  - "Cannot make a static reference to the non-static field" in **`main`** method
- Static methods cannot use the `this` keyword as there is no instance for this to refer to.

Exercise: `Bicycle.java`

- Write the class `Bicycle` that contains the following fields:
  - `cadence`
  - `gear`
  - `speed`
  - `id`
  - `numberOfBicycles`

- Primitive types or objects?
- Instance variables or static? Instantiate?

Exercise: **Bicycle.java**

```
public class Bicycle {

    private int cadence;
    private int gear;
    private int speed;
    private int id;

    private static int numberOfBicycles = 0;
```

Exercise: `Bicycle.java`

- Write the appropriate getters and setters for these variables

```
public int getID() {
    return id;
}

public static int getNumberOfBicycles() {
    return numberOfBicycles;
}
public int getCadence() {
    return cadence;
}

public void setCadence(int cadence) {
    this.cadence = cadence;

}
public int getGear(){
    return gear;
}
public void setGear(int gear) {
    this.gear = gear;

}
public int getSpeed() {
     return speed;
}
```

Exercise: `Bicycle.java`

- Create a non-parameterized constructor that sets the id to the number of bicycles and increases the counter

```java
public Bicycle() {
        id = ++numberOfBicycles;
}
```

- Create a constructor that takes 3 parameters: cadence, gear, speed. How can you use the previous constructor?

```java
 public Bicycle(int cadence, int speed, int gear) {
        this();
        this.cadence = cadence;
        this.gear = gear;
        this.speed = speed;
    }
```

Exercise: `Bicycle.java`

- Write a `main` method within your class
- Print the total number of bicycles
- Create an object (`unknown`) using the non-parameterized constructor
- Print its gear field
- Create an object (`myBike`) passing the following 3 arguments (2, 3, 5).
- Print its speed
- Print the total number of bicycles

Exercise: **Bicycle.java**

```
public static void main (String args[]) {
    System.out.println(Bicycle.numberOfBicycles);
    Bicycle unknown = new Bicycle();
    System.out.println(unknown.getGear());
    Bicycle myBike = new Bicycle(2,3,5);
    System.out.println(myBike.getSpeed());
    System.out.println(Bicycle.getNumberOfBicycles());
}
```

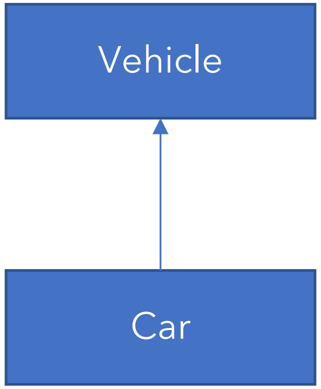
A vocabulary refresher for variables

- **Declaration:** state the type of variable and its identifier. A variable can only be declared once. E.g. `int x;`
- **Initialization:** the first time a variable takes a value. E.g., `x = 3;`
    - Can be combined with declaration, e.g., `int y = 3;`
- **Assignment:** discarding the old value and replacing it with a new.
    - `x = 2;`
- Static or instance variables are automatically initialized with default values, i.e. `null` for objects, 0 for `int`, `false` for `boolean`, etc.
- Local variables are not automatically initialized and your code won't compile if you have not initialized them and you are trying to use them. E.g.,

```
public void foo() {
    int x;
    System.out.println(x);
    //The local variable x might not have been initialized
}
```

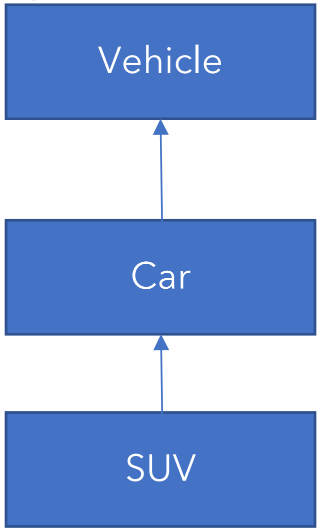
Inheritance

- When you want to create a new class and there is already a class that includes some of the code you want your new class to have, you can derive the new class from the existing class → reuse code!
- We say that a class *extends* or *inherits* another class
- E.g., `public class Car extends Vehicle`
- `Car` is a subclass of `Vehicle`
- `Vehicle` is a superclass of `Car`
- `Car` IS-A `Vehicle`



Inheritance in Java

- A subclass inherits all of the `public` and `protected` members of parent
- *Hiding:* same name of variables or of static method between super and subclass
- *Overriding:* same signature of instance methods between super and subclass
- Single inheritance!
  - A class can only extend ONE AND ONLY ONE class
- Multilevel inheritance
  - Class `SUV` extends class `Car` which extends class `Vehicle`



Example: Animal.java

```java
public class Animal {
    public int legs = 2;
    public static String species = "Animal";
    public static void testClassMethod() {
        System.out.println("The static method in Animal");
    }
    public void testInstanceMethod() {
        System.out.println("The instance method in Animal");
    }
}
```

Example: `Cat.java`

```java
public class Cat extends Animal {
    public int legs = 4;
    public static String species = "Cat";
    public static void testClassMethod() {
        System.out.println("The static method in Cat");
    }
    public void testInstanceMethod() {
        System.out.println("The instance method in Cat");
    }
}
```

Hiding vs Overriding

```
public static void main(String[] args) {
    Cat myCat = new Cat();
    myCat.testClassMethod(); //invoking a hidden method
    myCat.testInstanceMethod(); //invoking an overridden method
    System.out.println(myCat.legs); //accessing a hidden field
    System.out.println(myCat.species); //accessing a hidden field
}
```

- Output: “The static method in Cat\nThe instance method in Cat\n4\nCat”
- What you were expecting, right?

Hiding vs Overriding

```
public static void main(String[] args) {
    Animal yourCat = new Cat();
    yourCat.testClassMethod(); //invoking a hidden method
    yourCat.testInstanceMethod(); //invoking an overridden method
    System.out.println(yourCat.legs); //accessing a hidden field
    System.out.println(yourCat.species); //accessing a hidden field
}
```

- Output: "The static method in Animal\nThe instance method in Cat\n2\nAnimal"
- **Hiding**: For fields (instance+static) and methods (static) the class is determined at compile-time. Here, the compiler sees that `yourCat` is declared as `Animal`.
- **Overriding**: For instance methods this is determined at run-time. At this point, we know that `yourCat` is of type `Cat`
- One form of *polymorphism (dynamic)*

`super` keyword

- refers to the direct parent class of the current class
- `super.variable` (for hidden fields → avoid altogether)
- `super.instanceMethod()` (for overridden methods)
- `super(args)` → to call the constructor of the superclass
  - First line in subclass constructor

All classes inherit `Object`

- Directly (if they do not extend any other class) or indirectly
- Object class has methods (and more):
  - `public boolean equals (Object other)`
    - Default behavior returns true only if same object
  - `public String toString()`
    - Returns string representation of object – default is hexadecimal
    - Does not print the string
    - Typically needs to be overridden to be useful
  - `public int hashCode()`
    - Unique identifier defined so that if `a.equals(b)` then a, b have same hashCode

final

- variable – only assigned once in its declaration or in constructor – its value cannot change initialization
  - Often paired with static, e.g., static final PI = 3.14;
- method – cannot be overridden by subclass
- class - cannot be extended

`abstract`

- Class – cannot be instantiated but can be extended

- Method – declared without an implementation
  - no braces and body, just semicolon
  - `public abstract int enrollInClass(int classID);`

- If a class has at least one abstract method then it should be declared abstract itself

- If you extend an abstract class either declare subclass as abstract too or implement all abstract methods

Interfaces

- Contracts on how the program should work, abstracting from implementation
  - `public interface Moveable{…}`
- A class can *implement* many interfaces
  - `public class Car extends Vehicle implements Moveable`
- Variables – implicitly `public`, `static`, and `final`
- Methods – implicitly `public` (abstract, default, or static)
- Cannot be instantiated
- Can extend any number of interfaces
  - `public interface GroupedInterface extends Interface1, Interface2`

Example: `Moveable` interface

```
public interface Moveable{
      int turn(Direction direction, double radius, double speed);

      default int stop(){
            speed=0;
      }
}

public class Car extends Vehicle implements Moveable{
      int turn(Direction direction, double radius, double speed){
            //code goes here
      }
}
```

Abstract Classes vs Interfaces

• Can declare fields that are not static and final	• All fields are public, static, final
• Can define public, protected, private concrete methods	• All methods are public
• Can extend only one class whether or not abstract	• Can implement any number of interfaces

Nested class

- A class defined within a class

```
class Outer{
    …
    static class Nested{…}
    class Inner{…}
}
```

- Logically groups classes that are only used once in one place
- Increases encapsulation
- Better code

Enum Types

- Example
  - `enum Suit {CLUBS, DIAMONDS, HEARTS, SPADES}`
- Operations:
  - `int compareTo(Suit other)`
  - `String toString()`
  - `int ordinal()` returns position in its enum declaration. *starts with 0*
  - `static Suit valueOf(String name)`
  - `static Suit[] values()` *returns array of all values*

Documentation

- Important for code maintainability
  - This matters even for 1st week assignments
- Critical when working on a team
- Create documentation first– this is design work!

JavaDoc

- Document generation system
  - Reads JavaDoc comment →HTML pages

- JavaDoc comment = description written in HTML + tags

- Enclosed in /**   */

- Must precede class, variable, constructor or method declaration

- Read the style guide

JavaDoc

- Common tags:
  - for class:
    - **@author** author name – classes and interfaces
    - **@version** date - classes and interfaces
  - for method:
    - **@param** param name and description – methods and constructors
    - **@return** value returned, if any – methods
    - **@throws** description of any exceptions thrown - methods

Packages

- Use them! E.g., `package assignment1;` … before everything else
- Package name == folder name
- Helps organize large projects e.g, `java.lang`→fundamental
- Import a package member: `import package.member;`
- Import an entire package: `import package.*;`

Question Time

```java
public class IdentifyMyParts {
    public static int x = 7;
    public int y = 3;
}
```

- What is the output from the following code:

```java
IdentifyMyParts a = new IdentifyMyParts();
IdentifyMyParts b = new IdentifyMyParts();
a.y = 5;
b.y = 6;
a.x = 1;
b.x = 2;
System.out.println("a.y = " + a.y);
System.out.println("b.y = " + b.y);
System.out.println("a.x = " + a.x);
System.out.println("b.x = " + b.x);
System.out.println("IdentifyMyParts.x = "+  IdentifyMyParts.x);
```