Writing New Java Classes

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Margaret Reid-Miller

What Are Objects?

- What are objects and what are not objects?
  - Objects: bicycle, book, lamp, song, meeting
  - Non-objects: green, 30% of all pencils, large
- If you can touch it, name it, or talk about it, it is likely to be an object.
- Objects can be physical things or conceptual.
- Humans seem to want to think in terms of objects and their relationships with each other.

Object Features

- When we try to describe an object, we tend to
  - name or label it (e.g., Homer's car)
  - say what it can do (e.g., turn, drive, brake)
  - list its attributes or properties (e.g., red, 4-door)
- Sometimes we clarify the way that it does something (e.g., how fast to drive or what direction to turn).
- Sometimes the properties are observable from the outside (*visible*); sometimes we can only inferred them from the way the object behaves (*hidden*).

  Example:
  - Visible: V-8 engine, has a sun-roof
  - Hidden: The amount of fuel in the tank is indirectly determined by the fuel gauge.

Models and Programs

- Often computer programs model some process or system.
- A model is a simplified representation:
  - It includes features that are important for the aim of the system.
  - Excludes features that are not relevant to the situation.
- When we model objects we define what is common for all objects of a particular type and then state what is special about each individual object. (e.g, All cars have a color, have an engine, drive forward, and turn. But a particular car may be silver with a V8 engine).

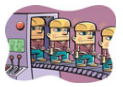
Software Objects

- In object-oriented programming we describe ***types of objects*** by defining classes.
- A Java class definition contains
  - ***fields*** - what *properties* an object has
    - The values assigned to the fields define the *state* of the object. (e.g., the car is painted silver, has a half a tank of gas, and is stopped.)
  - ***methods*** - what *behaviors* (actions) an object can perform
    - Typically these actions supply or modify its state.

Software Objects

- A Java class is a "blue print" for creating objects of that type.
- We then can create multiple objects from that class and "fill in" the properties with values specific to each object, and ask the object to perform their behaviors.
- Every object belongs to one class and is an ***instance of the class.***
- Types of objects that we have used are

  `String, Scanner, File, PrintStream, Die, Spinner, TrainCar`

Fields

- The ***fields*** (*instance variables*) of an object are the variables that define an object's properties.

  Example: An object from an Elevator class might have the following fields:
  - the current floor,
  - the top floor,
  - the number of riders, and
  - the capacity.
- Once an object is created, each field has some value.
- These values define the ***state*** of the object and describe the current condition of the object.

`Elevator` class

Fields

initial capital

```
public class Elevator {
   // Fields: The object state
   private int topFloor;       // maximum floor number
   private int currentFloor;
   private int capacity;       // max number of riders
   private int numRiders;

  // Methods: The object behaviors

}
```

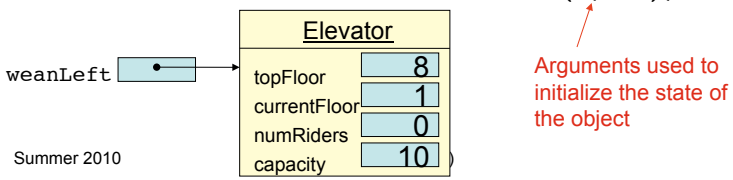
Fields should be defined as **`private`** (visible to methods of the same class and hidden to methods of other classes).

Creating Objects

- A class provides a blueprint for objects of the type of the class.
- Use the **`new`** operator to ***instantiate*** (create) the object, followed by a call to the class constructor, which initializes the object's fields. The **`new`** operator returns a ***reference*** to the new object.

  For example in the `main` method we might write:

```
Elevator weanLeft = new Elevator(8, 10);
```



Constructors

Constructors initializes **all** the fields of the object.

```
public Elevator(int numberOfFloors,
                int maxRiders) {
    topFloor = numberOfFloors;
    currentFloor = 1;      // Starting floor
    capacity = maxRiders;
    numRiders = 0;         // Initially empty
}
```

NOTE: For each parameter, use a name different from the field names.

Constructors

- Constructors are like methods with two differences:
  - There is no return type. (The object reference returned **always** has the type of the class.)
  - The name of the constructor is **always** the name of the class.
- The constructor should initializes all the fields of the object.
- Any Java statement can be in the body of the constructor. For example it might check that a parameter is in the correct range of values.

Overloading

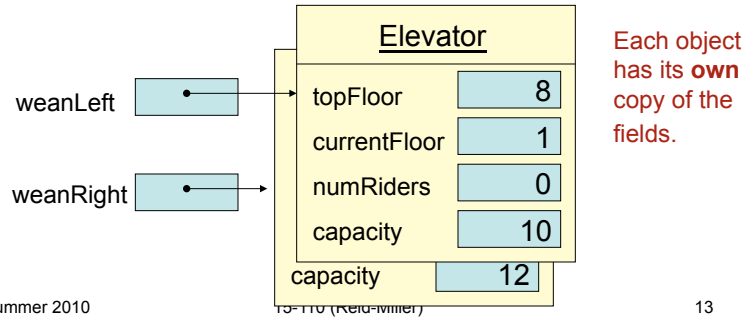
- We can have more than one constructor.
- Additional constructors can supply default values for fields that have no corresponding parameter.

```
public Elevator(int numberOfFloors) {
      topFloor = numberOfFloors;
      currentFloor = 1;  // Starting floor
      capacity = 12;     // Standard capacity
      numRiders = 0;   // Initially empty
}
```

default value

Sample *Client* Program

```
public class ElevatorController {
  public static void main(String[] args){
      Elevator weanLeft = new Elevator(8,10);
      Elevator weanRight = new Elevator(8);
```



Each object has its **own** copy of the fields.

(Instance) Methods

- The ***behaviors*** of an object are defined by the methods we write in the object's class.
- These (instance) methods report or act upon the data of an object (instance of the class).
- One of the biggest benefit's of object-oriented programming is that we put both the data and methods together.
- The program code that creates and uses these objects, called the *client* code, is now more expressive and concise. It simply asks the objects to perform their behaviors (i.e., to provide a *service*).

Accessors

- ***Accessors*** are methods that access an object's state without changing the state.

Examples:

```
public int getNumRiders() {
   return numRiders;
}

public int getCurrentFloor() {
   return currentFloor;
}
```

No `static` keyword

Names often begin with "get"

Accessors should be defined as **`public`** (visible by everyone).

Accessors

Or names begin with "is"

```
public boolean isFull() {
   return numRiders == capacity;
}
```

This accessor compares the number of riders with the capacity and returns `true` if the elevator is at its maximum capacity and `false` otherwise. It does not change the state of the object.

Using an Accessor

- How can we invoke the `getNumRiders` method in the `main` method?

```
num = Elevator.getNumRiders();                NO!
leftNum = weanLeft.getNumRiders(3);           NO!
weanLeft.getNumRiders();                      NO!
int weanLeftNum = weanLeft.getNumRiders();  YES!
System.out.println(
             weanLeft.getNumRiders());        YES!
if (weanLeft.getNumRiders() < 10){            YES!
   System.out.println("not full");
}
```


Mutators

- ***Mutators*** are methods that can change an object's state.

returns no value

```
public void addRiders(int numEntering) {
  if (numRiders + numEntering <= capacity) {
    numRiders = numRiders + numEntering;
  } else {
    numRiders = capacity;
  }
}
```

Mutators should be defined as **`public`** (visible to methods of every class).

Mutators

- ***Mutators*** should ensure that the object's state stays consistent, e.g., that the number of riders is never greater than the elevator capacity or negative, and that the elevator never goes to a nonexistent floor of the building.

```
public void goUpOneFloor() {
if (currentFloor < topFloor)
        currentFloor++;
}
```

In another class, to call this method:

```
weanLeft.goUpOneFloor();
```


The toString Method

- Every class should have a `toString()` method that returns a string that represents the current state of the object.

Required signature

```
public String toString() {

    return "current floor = " + currentFloor
        + " top floor = " + topFloor
        + "\nnumber of riders = " + numRiders
    + " capacity = " + capacity;

}
```

Invoking toString()

Typically, `toString` is used for debugging.

```
public class ElevatorController {
  public static void main(String[] args){
      Elevator weanLeft = new Elevator(8,10);
      Elevator weanRight = new Elevator(8);
      weanLeft.addRiders(5);
      weanLeft.goUpOneFloor();
      System.out.println("Left: " + weanLeft);
```

Java invokes `toString` on object references in print statements and string concatenation expressions automatically.

The equals Method

- Every class should have an `equals` method that compares two objects and returns `true` if they have the same **state** and `false` otherwise.

```
public boolean equals(Elevator other) {
     return topFloor == other.topFloor &&
     currentFloor == other.currentFloor &&
     capacity == other.capacity &&
     numRiders == other.numRiders;
}
```

Like methods, use dot to access an object's fields.

In another class, to call this method:

```
if (weanLeft.equals(weanRight))
```


The `this` Reference

- The reserved word `this` allows an object to refer to itself within its class. (It is sometimes called the *implicit parameter*.)

```
public Elevator(int topFloor, int capacity) {
  this.topFloor = topFloor;
…
}
public boolean equals(Elevator other) {
   return this.topFloor == other.topFloor &&
…
}
Usage: if (weanLeft.equals(weanRight)) …
```

shadows the field

field

Remarks

- The fields (properties) of a class define what space in memory is needed to hold the current state of the object. They should be private.
- The public methods of a class define the behaviors of the objects. These methods define the *interface* to the object; The interface defines what client code in other classes can ask the objects to do. (Private methods are "helper" methods that help the public methods to their job.)
- Fields and methods for the instances of the class (objects) do **not** include the `static` keyword.