Object-Oriented Programming in Java: More Capabilities

Topics in This Section

- **Overloading**
- **Best practices for “real” classes**
  - Encapsulation and accessor methods
  - JavaDoc
- **Inheritance**
- **Packages**
- **The toString method**
- **More iterations of the Person class**

Overloading

- **Idea**
  - Classes can have more than one method with the same name, or more than one constructor
  - The methods or constructors have to differ from each other by having different number or types of arguments

- **Syntax example**

```
public class MyClass {
   public double randomNum() { … };   // Range 1-10
   public double randomNum(double range) { … }
}
```

Motivation

- **Overloading methods**
  - Lets you have similar names for similar operations
    - MathUtils.arraySum(arrayOfInts)
    - MathUtils.arraySum(arrayOfDoubles)
    - MathUtils.log(number) // Assumes $\log_e$(number)
    - MathUtils.log(number, base) // $\log_{base}$(number)
- **Overloading constructors**
  - Lets you build instances in different ways
    - new Ship(someName) // Default x, y, speed, direction
    - new Ship(someX, someY, someSpeed, someDirection, someName)

Ship Example: Overloading (ship4/Ship.java)

```
package ship4;

public class Ship {
  public double x=0.0, y=0.0, speed=1.0, direction=0.0;
  public String name;

  public Ship(double x, double y,
              double speed, double direction,
              String name) {
    this.x = x;
    this.y = y;
    this.speed = speed;
    this.direction = direction;
    this.name = name;
  }

  public Ship(String name) {
    this.name = name;
  }
  ...
```

Overloading (Continued)

```
  ...

  public void move() {
    move(1);
  }

  public void move(int steps) {
    double angle = degreesToRadians(direction);
    x = x + steps * speed * Math.cos(angle);
    y = y + steps * speed * Math.sin(angle);
  }

  // degreesToRadians and printLocation as before
}
```

Ship Tester

```
package ship4;

public class ShipTest {
  public static void main(String[] args) {
    Ship s1 = new Ship("Ship1");
    Ship s2 = new Ship(0.0, 0.0, 2.0, 135.0, "Ship2");
    s1.move();
    s2.move(3);
    s1.printLocation();
    s2.printLocation();
  }
}
```

Overloading: Results

- **Compiling and running in Eclipse (common)**
  - Save Ship.java and ShipTest.java
  - R-click inside ShipTest.java, Run As → Java Application

- **Compiling and running manually (rare)**

```
> javac ship4\ShipTest.java
> java ship4.ShipTest
```

- **Output:**

```
Ship1 is at (1.0,0.0).
Ship2 is at (-4.24264...,4.24264...).
```

OOP Design: Best Practices

- **Ideas**
  - Instance variables should *always* be private
    - And hooked to outside world with getBlah and/or setBlah
  - From very beginning, put in JavaDoc-style comments

- **Syntax example**

```
/** Short summary. More detail. Can use HTML. */
public class MyClass {
  private String firstName;
  public String getFirstName() { return(firstName); }
  public void setFirstName(String s) { firstName = s; }
}
```

Motivation

- **Supports secondary goal of OOP**
  - Limits ripple effect, where changes to one class requires changes to the classes that use it, that require changes to the classes that use that, and so forth
    - Lets you make changes to internal representation of classes without changing its public interface
    - Makes code more maintainable

OOP Principles

- **Basic OOP principles**
  - Primary goal: avoid needing to repeat identical or almost-identical code
    - DRY: Don't Repeat Yourself
    - Code reuse
  - Secondary goal: limit ripple effect
    - Where changes to one piece of code requires changes to the pieces that use it
- **Advanced OOP principles**
  - SOLID
    - http://en.wikipedia.org/wiki/SOLID_%28object-oriented_design%29
    - http://williamdurand.fr/2013/07/30/from-stupid-to-solid-code/

Ship Example: OOP Design and Usage (ship5/Ship.java)

```
/** Ship example to demonstrate OOP in Java. */

public class Ship {
  private double x=0.0, y=0.0, speed=1.0, direction=0.0;
  private String name;
  …
  /** Get current X location. */

  public double getX() {
    return(x);
  }

  /** Set current X location. */

  public void setX(double x) {
    this.x = x;
  } …
```

Ship Tester

```
package ship5;

/** Small example to test the Ship class.
 *  <p>
 *  From <a href="http://www.coreservlets.com/">the
 *  coreservlets.com Java tutorials</a>.
 */
public class ShipTest {
 public static void main(String[] args) {
    Ship s1 = new Ship("Ship1");
    Ship s2 = new Ship(0.0, 0.0, 2.0, 135.0, "Ship2");
    s1.move();
    s2.move(3);
    s1.printLocation();
    s2.printLocation();
  }
}
```

Results

- **Compiling and running in Eclipse (common)**
  - Save Ship.java and ShipTest.java
  - R-click inside ShipTest.java, Run As → Java Application
  - Select project, go to Project menu and choose "Generate Javadoc"
    - If it asks you where javadoc.exe is located, you can find it in the bin folder of your Java installation (e.g., C:\Program Files\Java\jdk1.8.0_75\bin)
- **Compiling and running manually (rare)**

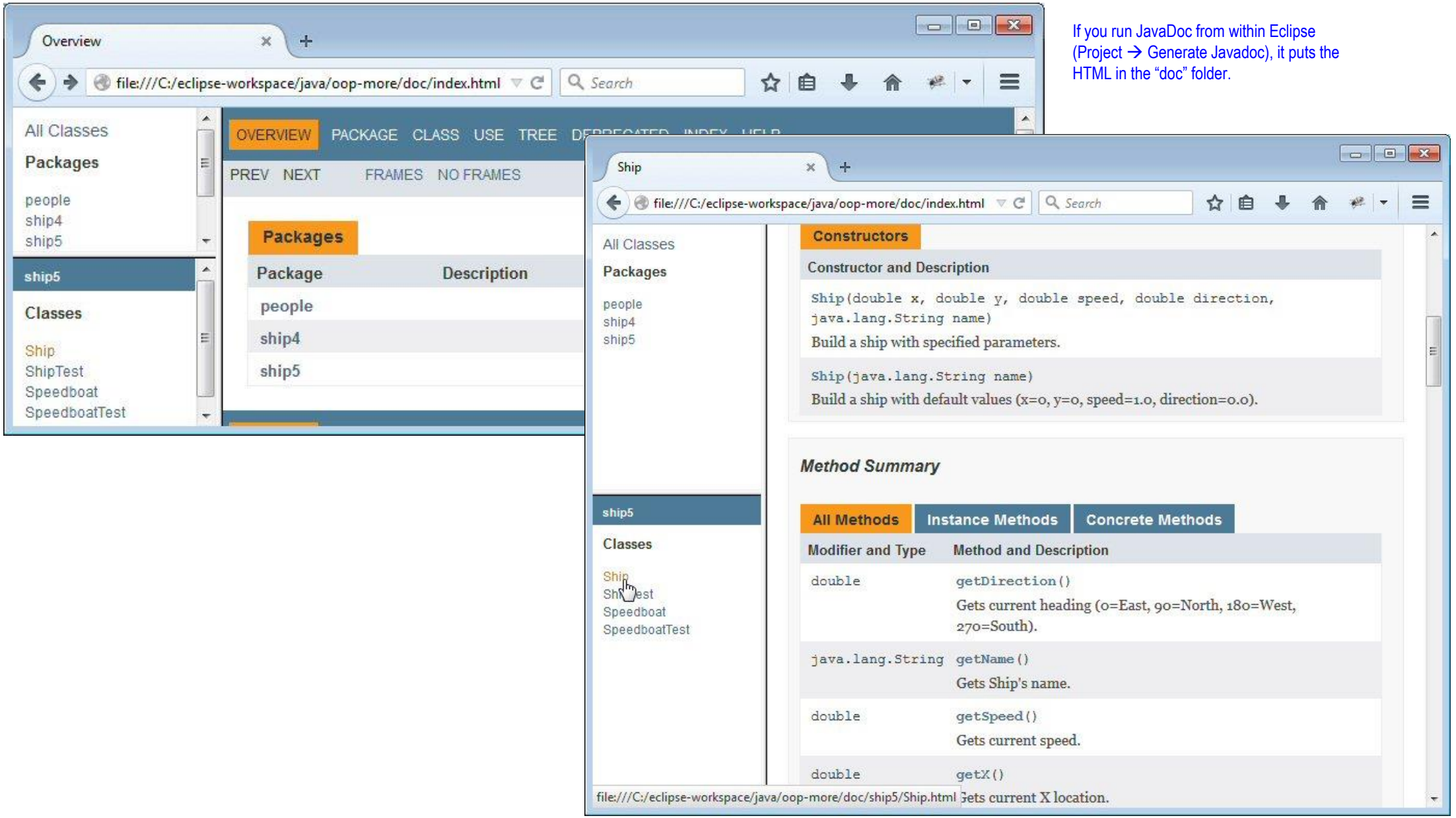
```
> javac ship5\ShipTest.java
> java ship5.ShipTest
> javadoc *.java
```

- **Output:**

```
Ship1 is at (1.0,0.0).
Ship2 is at (-4.24264...,4.24264...).
```

OOP Design: Testing and Results (Continued)

If you run JavaDoc from within Eclipse (Project → Generate Javadoc), it puts the HTML in the "doc" folder.



Major Points

- **Encapsulation**
  - Lets you change internal representation and data structures *without users of your class changing their code*
  - Lets you put constraints on values *without users of your class changing their code*
  - Lets you perform arbitrary side effects *without users of your class changing their code*
- **Comments and JavaDoc**
  - Comments marked with /** ... */ will be part of the online documentation
    - These should go before every public class, every public method, and every public constructor
  - To build online documentation within Eclipse, do Project → Generate Javadoc
  - To build the documentation from command line, use "javadoc *.java"

More Details on Getters and Setters

- **Eclipse will automatically build getters/setters from instance variables**
  - R-click anywhere in code
  - Choose Source → Generate Getters and Setters
  - However, if you later click on instance variable and do Refactor → Rename, Eclipse will not automatically rename the accessor methods

More Details on Getters and Setters

- **There need not be both getters and setters**
  - It is common to have fields that can be set at instantiation, but never changed again (immutable field). It is even quite common to have classes containing only immutable fields (immutable classes)

```
public class Ship {
  private final String shipName;

  public Ship(...) {  shipName = ...; ... }

  public String getName() { return(shipName); }

  // No setName method
}
```

More Details on Getters and Setters

- **Getter/setter names need not correspond to instance var names**
  - Common to do so if there is a simple correspondence, but this is not required
    - Notice on previous page that instance variable was “shipName”, but methods were “getName” and “setName”
  - In fact, there doesn’t even have to *be* a corresponding instance variable

```
public class Customer {
  ...
  public String getFirstName() { getFromDatabase(…); }
  public void setFirstName(…) { storeInDatabase(…); }
  public double getBonus() { return(Math.random()); }
}
```

Inheritance

- **Ideas**
  - You can make a class that “inherits” characteristics of another class
    - The original class is called “parent class”, “super class”, or “base class”
    - The new class is called “child class”, “subclass”, or “extended class”
  - The child class has access to all non-private methods of the parent class
    - No special syntax need to call inherited methods

- **Syntax example**

```
public class ChildClass extends ParentClass {
   ...
}
```

Motivation

- **Supports primary goal of OOP**
  - Supports the key OOP principle of code reuse
    - I.e., don't write identical or nearly-identical code twice
  - You can design class hierarchies so that shared behavior is inherited by all classes that need it

Simple Example

- **Person**

```
public class Person {
  public String getFirstName() { ... }
  public String getLastName() { ... }
}
```

- **Employee**

```
public class Employee extends Person {
  public double getSalary() { ... }

  public String getEmployeeInfo() {
    return(getFirstName() + " " + getLastName() +
           " earns " + getSalary());
  }
}
```

Ship Example: Inheritance

```
public class Speedboat extends Ship {
  private String color = "red";

  public Speedboat(String name) {
    super(name);
    setSpeed(20);
  }

  public Speedboat(double x, double y, double speed, double direction,
                   String name, String color) {
    super(x, y, speed, direction, name);
    setColor(color);
  }

  @Override // Optional but useful -- discussed later
  public void printLocation() {
    System.out.print(getColor().toUpperCase() + " ");
    super.printLocation();
  }
  ...
}
```

Inheritance Example: Testing

```
public class SpeedboatTest {
  public static void main(String[] args) {
    Speedboat s1 = new Speedboat("Speedboat1");
    Speedboat s2 = new Speedboat(0.0, 0.0, 2.0, 135.0,
                                 "Speedboat2", "blue");
    Ship s3 = new Ship(0.0, 0.0, 2.0, 135.0, "Ship1");
    s1.move();
    s2.move();
    s3.move();
    s1.printLocation();
    s2.printLocation();
    s3.printLocation();
  }
}
```

Inheritance Example: Result

- **Compiling and running in Eclipse**
  - Save SpeedBoatTest.java
  - R-click, Run As → Java Application
- **Compiling and running manually**

```
> javac ship5\SpeedboatTest.java
```

  - The above calls javac on Speedboat.java and Ship.java automatically

```
> java ship5.SpeedboatTest
```

- **Output**

```
RED Speedboat1 is at (20,0).
BLUE Speedboat2 is at (-1.41421,1.41421).
Ship1 is at (-1.41421,1.41421).
```

Ship Inheritance Example: Major Points

- **Format for defining subclasses**
  - And nomenclature (parent/child, super/sub, base/extended)
- **Using inherited methods**
  - No special syntax required
- **Using super(…) for inherited constructors**
  - *Only* when the zero-arg constructor is not OK
    - The most common case is to omit super and use zero-arg constructor of parent, but super is used moderately often

if u dont call super constructor super() gets auto called

- **Using super.someMethod(…) for inherited methods**
  - *Only* when there is a name conflict
    - Used rarely

Review of Packages

- **Idea**
  - Organize classes in groups.
- **Syntax**
  - Make folder called somepackage
    - In Eclipse, R-click on “src” and do New → Package
  - Put “package somepackage” at top of file
    - Automatic in Eclipse
  - To use code from another package
    - put “import somepackage.*” below your package statement

Motivation

- **Avoiding name conflicts**
  - Team members can work on different parts of project without worrying about what class names other teams use
- **Different versions for testing**
  - For example, in next section, I have three packages: shapes1, shapes1, shapes3. They have variations on ways to make shapes where you can sum their areas.
    - But I use same core class names (Circle, Rectangle, etc.) in each of the packages

Running Packaged Code that has “main”

- **From Eclipse**
  - Same as always: R-click, Run As → Application
- **From command line**
  - Go to top-level of package hierarchy, i.e., for simple packages, the folder above the one containing the Java code
  - Use the fully-qualified name, i.e., including package

```
> java packagename.Classname ...
```

The toString Method

- **Idea**
  - If you give a class a toString method, that method is *automatically* called whenever
    - An object of that class is converted to a String
    - An object of that class is printed
- **Example**

```
public class Person {
  // Main code covered earlier

  @Override
  public String toString() {
    return("PERSON: " + getFullName());
  }
}
```

Preview of @Override

- **Oddities of toString**
  - We write the method, but we never call it
  - If we spell method wrong, we don't know until run time
    - @Override useful for both issues; more details later

- **What will be printed on final line below?**

```
public class Person {
   ...
   public void tostring() { return(getFullName()); }
}
...
Person p = new Person(...);
System.out.println(p);
```

Iterations of Person

- **Last lecture: four iterations of Person**
  - Instance variables
  - Methods
  - Constructors
  - Constructors with “this” variable
- **This lecture**
  - Person class
    - Change instance vars to private, add accessor methods
    - Add JavaDoc comments
    - Use toString
  - Employee class
    - Make a class based on Person that has all of the information of a Person, plus new data

Person Class (Part 1)

```
/** A class that represents a person's given name
 *  and family name.
 */
public class Person {
  private String firstName, lastName;

  public Person(String firstName,
                String lastName) {
    this.firstName = firstName;
    this.lastName = lastName;
  }
```

Person Class (Part 2)

```
/** The person's given (first) name. */

public String getFirstName() {
  return (firstName);
}

public void setFirstName(String firstName) {
  this.firstName = firstName;
}
```

Person Class (Part 3)

```
/** The person's family name (i.e., last name or surname). */

public String getLastName() {
  return (lastName);
}

public void setLastName(String lastName) {
  this.lastName = lastName;
}

/** The person's given name and family name, printed
 *  in American style, with given name first and
 *  a space in between.
 */
public String getFullName() {
  return(firstName + " " + lastName);
}
}
```

Employee Class (Part 1)

```
/** Represents people that work at a company. */

public class Employee extends Person {
  private int employeeId;
  private String companyName;

  public Employee(String firstName, String lastName,
                  int employeeId, String companyName) {
    super(firstName, lastName);
    this.employeeId = employeeId;
    this.companyName = companyName;
  }
```

Employee Class (Part 2)

```
/** The ID of the employee, with the assumption that
 *  lower numbers are people that started working at
 *  the company earlier than those with higher ids.
 */
 public int getEmployeeId() {
   return (employeeId);
 }

 public void setEmployeeId(int employeeId) {
   this.employeeId = employeeId;
 }
```

Employee Class (Part 3)

```
  /** The name of the company that the person
   *  works for.
   */
  public String getCompanyName() {
    return (companyName);
  }

  public void setCompanyName(String companyName) {
    this.companyName = companyName;
  }
}
```

Summary

- **Overloading**
  - You can have multiple methods or constructors with the same name. They must differ in argument signatures
- **Best practices**
  - Make *all* instance variables private. Hook them to the outside with getBlah and/or setBlah
  - Use JavaDoc-style comments from the very beginning
- **Inheritance**
  - `public class Subclass extends Superclass { … }`
    - Non-private methods available with no special syntax
- **Organization**
  - Put all code in packages
  - Make output more readable by implementing toString