











Object-Oriented Programming in Java: **More Capabilities**

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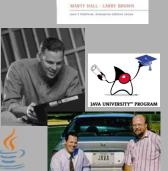












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> Taught by lead author of Core Servlets & JSP, co-author of *Core JSF* (4th Ed), and this tutorial.

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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

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Overloading







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Overview

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)

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**

"Always code as if the guy who ends up maintaining your code will be a violent psychopath who knows where you live."

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Overview

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

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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.

* 
* 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)

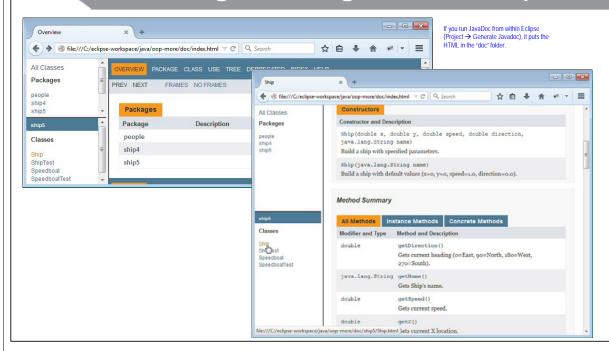
Compiling and running manually (rare)

- > javac ship5\ShipTest.java
- > java ship5.ShipTest
- > javadoc *.java
- Output:

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

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OOP Design: Testing and Results (Continued)



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

Q: What is the object-oriented way of getting rich?

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Overview

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

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Simple Example

Person

Ship Example: Inheritance

Inheritance Example: Testing

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).
```

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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

Using super.someMethod(...) for inherited methods

- Only when there is a name conflict
 - Used rarely













Review of Packages



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Overview

- 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

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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



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Overview

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);
```

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Example: Person Class

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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

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Person Class (Part 1)

Person Class (Part 2)

```
/** The person's given (first) name. */
public String getFirstName() {
  return (firstName);
}

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

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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)

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;
  }
}
```

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Java OOP References

Online

- "OOP Concepts" section in Oracle Java Tutorial. See also "Classes and Objects" and "Interfaces and Inheritance".
 - http://docs.oracle.com/javase/tutorial/java/

Books

- Murach's Java SE (Murach, Steelman, and Lowe)
 - Excellent Java intro for beginners to Java (but not first-time programmers). Very good OOP section.
- Thinking in Java (Bruce Eckel)
 - Perhaps not quite as good as Murach's book in general, but possibly the best OOP coverage of any Java programming book.
- Effective Java, 2nd Edition (Josh Bloch)
 - In my opinion, by far the best Java best-practices book ever written. Fantastic coverage of OOP best practices.
 - However, <u>very</u> advanced. Other than the OOP chapter, you won't understand much unless you have been doing Java fulltime for at *least* a year.
 - Even experts will learn a lot from this book.

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





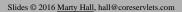








Questions?





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