CSE 143

Programming as Modeling

Reading: Ch. 1-6

Building Virtual Worlds

- Much of programming can be viewed as building a *model* of a real or imaginary world in the computer
  - a banking program models real banks with customers, accounts, etc.
  - a checkers program models a real game
  - a fantasy game program models an imaginary world
  - a word processor models an intelligent typewriter and documents
- Running the program (the model) simulates what would happen in the modeled world

  (And if the model is good for the intended purposes, the simulation tells us useful things about the things we are modeling)
- Often it's a lot easier or safer to build models than the real thing
  - Example: a tornado simulator

Java Tools for Modeling

- *Objects* in Java can model *things* in the (real or imaginary) world
  - The bank: Customers, employees, accounts, transactions...
  - Checkers: The Checkerboard, pieces, players, game history
  - Video game: Characters, landscapes, obstacles, weapons, treasure, scores
  - Documents: paragraphs, words, symbols, spelling dictionaries, fonts, smart paper-clip
- Key notion: Objects have
  - Responsibilities – what you can ask them to do
  - Properties – what they know

Basic Java Mechanisms for Modeling

- A *class* describes a *template* or *pattern* for things; an *object* or *instance* of a class is a *particular* thing
- *Constructors* model ways to create new instances
- *Methods* model *actions* that these things can perform (i.e., to carry out their responsibilities)
- *Messages* (method calls) model requests from one thing to another
- *Instance variables* model the state or properties of things
- **`public`** vs. **`private`**
  - Instance variables should normally be private
  - Methods should be public or private depending on whether they should be visible to code in other classes

What Makes a Good Model?

- Often, the closer the model matches the (real or imaginary) world, the better
  - More likely it's an accurate model
  - Easier for human readers of the program to understand what's going on in the program
- Sometimes, a too detailed model of reality is not a good thing
  - Why?

What Else Makes a Good Model?

- The easier the model is to extend & evolve, the better
  - May want to extend the model...
  - May need to change the model...
- Sad law of life: “A Program is Never Finished”
  - Or at least a *useful* program is never finished
- Why??

Coupling and Cohesion

- A qualitative way to evaluate the organization of classes or modules
- *Coupling* – the degree to which a class interacts with or depends on another class
- *Cohesion* – how well a class encapsulates a single notion
- A system is more robust and easier to maintain if
  - Coupling between classes/modules is minimized
  - Cohesion within classes/modules is maximized

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A Review Example

```
/** Representation of an employee in a personnel system
 * @author Hal Perkins
 * @version CSE143 Wi04 lecture example */
public class Employee {
  // instance variables
  private String name;          // employee name
  private int     id;           // employee id number
  private double pay;           // employee weekly pay
  /** Construct a new employee with the give name, id number, and weekly pay
   * @param name Employee's name
   * @param id   Employee's id number
   */
  public Employee(String name, int id, double pay) {
    this.name = name;
    this.id       = id;
    this.pay     = pay;
  }
  ...
```

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Employee Example (2)

```
 /**
  * Return the name of this employee
  * @return Employee name
  */
 public String getName() {
   return name;
 }

 /**
  * Return the id number of this employee
  * @return Employee id number
  */
 public int getId() {
   return id;
 }

 ...
```

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Employee Example (3)

```
  ...

   /**
   * Return the pay earned by this employee
   * @return Employee's pay for the current pay period
   */
  public double getPay() {
    return pay;
  }

  /** Set this employee’s pay
   *  @param newPayRate new pay rate for this employee
   */
  public void setPay(double newPayRate) {
    pay = newPayRate;
  }
}
```

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toString: Recommended for All Classes

- A method with this exact signature:
  `public String toString( );`

```
/** Return a string representation of this employee */
public String toString( ) {
  return "Employee(name = " + name + ", id = " + id +
    ", pay = " + pay + ")";
}
```

- Java treats toString in a special way
  - In many cases, will automatically call toString when a String value is needed:
    `System.out.println(“The bank account: ” + account);`

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toString

- Good while debugging
  `System.out.println(anObject);  // calls anObject.toString()`
- Secret Java lore:
  - *All* Objects in Java have a built-in, default toString method
  - So why define your own??

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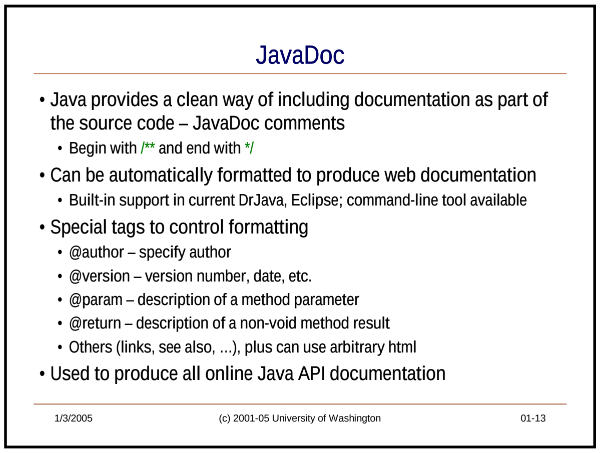

JavaDoc

- Java provides a clean way of including documentation as part of the source code – JavaDoc comments
  - Begin with /** and end with */
- Can be automatically formatted to produce web documentation
  - Built-in support in current DrJava, Eclipse; command-line tool available
- Special tags to control formatting
  - @author – specify author
  - @version – version number, date, etc.
  - @param – description of a method parameter
  - @return – description of a non-void method result
  - Others (links, see also, ...), plus can use arbitrary html
- Used to produce all online Java API documentation

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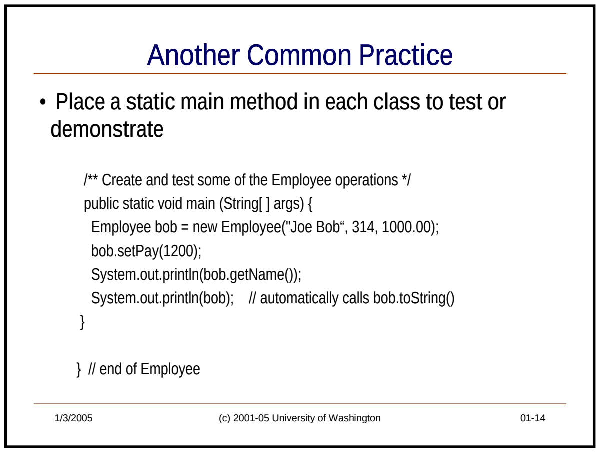

Another Common Practice

- Place a static main method in each class to test or demonstrate

```
/** Create and test some of the Employee operations */
public static void main (String[ ] args) {
  Employee bob = new Employee("Joe Bob“, 314, 1000.00);
  bob.setPay(1200);
  System.out.println(bob.getName());
  System.out.println(bob);    // automatically calls bob.toString()
}

} // end of Employee
```

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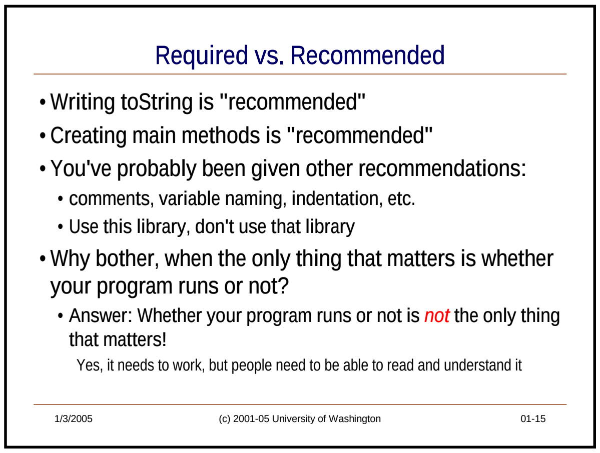

Required vs. Recommended

- Writing toString is "recommended"
- Creating main methods is "recommended"
- You've probably been given other recommendations:
  - comments, variable naming, indentation, etc.
  - Use this library, don't use that library
- Why bother, when the only thing that matters is whether your program runs or not?
  - Answer: Whether your program runs or not is *not* the only thing that matters!

    Yes, it needs to work, but people need to be able to read and understand it

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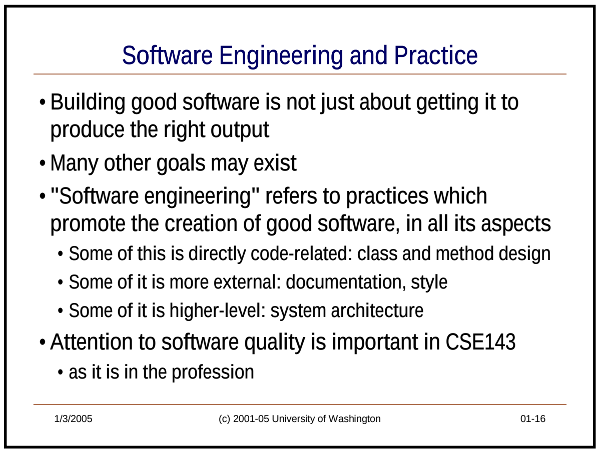

Software Engineering and Practice

- Building good software is not just about getting it to produce the right output
- Many other goals may exist
- "Software engineering" refers to practices which promote the creation of good software, in all its aspects
  - Some of this is directly code-related: class and method design
  - Some of it is more external: documentation, style
  - Some of it is higher-level: system architecture
- Attention to software quality is important in CSE143
  - as it is in the profession

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