

# Building Java Programs

Chapter 9  
Lecture 9-1: Inheritance

**reading: 9.1 - 9.2**

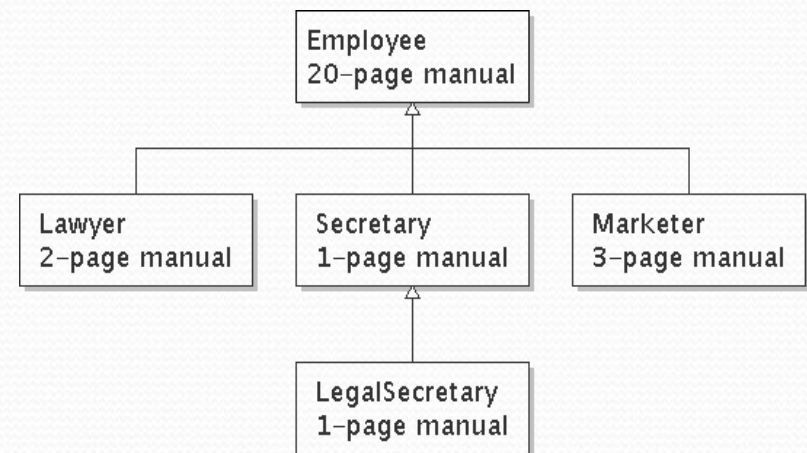
# The software crisis

- **software engineering:** The practice of developing, designing, documenting, testing large computer programs.
- Large-scale projects face many issues:
  - getting many programmers to work together
  - getting code finished on time
  - avoiding redundant code
  - finding and fixing bugs
  - maintaining, improving, and reusing existing code
- **code reuse:** The practice of writing program code once and using it in many contexts.



# Law firm employee analogy

- common rules: hours, vacation, benefits, regulations ...
  - all employees attend a common orientation to learn general company rules
  - each employee receives a 20-page manual of common rules
- each subdivision also has specific rules:
  - employee receives a smaller (1-3 page) manual of these rules
  - smaller manual adds some new rules and also changes some rules from the large manual



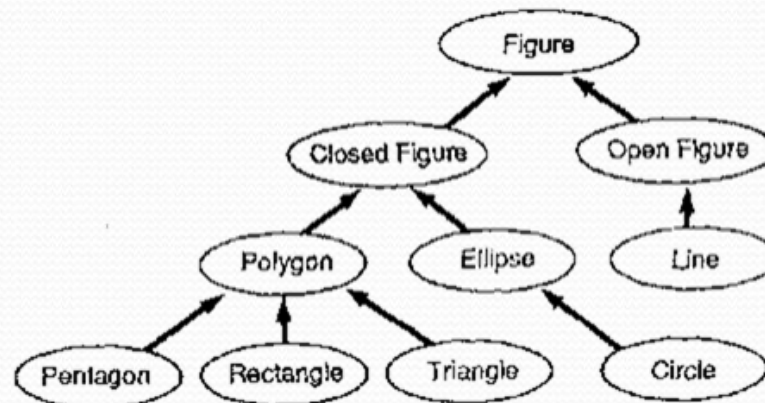
# Separating behavior

- Why not just have a 22 page Lawyer manual, a 21-page Secretary manual, a 23-page Marketer manual, etc.?
- Some advantages of the separate manuals:
  - maintenance: Only one update if a common rule changes.
  - locality: Quick discovery of all rules specific to lawyers.
- Some key ideas from this example:
  - General rules are useful (the 20-page manual).
  - Specific rules that may override general ones are also useful.



# Is-a relationships, hierarchies

- **is-a relationship:** A hierarchical connection where one category can be treated as a specialized version of another.
  - every marketer *is an* employee
  - every legal secretary *is a* secretary
- **inheritance hierarchy:** A set of classes connected by is-a relationships that can share common code.



# Employee regulations

- Consider the following employee regulations:
  - Employees work 40 hours / week.
  - Employees make \$40,000 per year, except legal secretaries who make \$5,000 extra per year (\$45,000 total), and marketers who make \$10,000 extra per year (\$50,000 total).
  - Employees have 2 weeks of paid vacation leave per year, except lawyers who get an extra week (a total of 3).
  - Employees should use a yellow form to apply for leave, except for lawyers who use a pink form.
- Each type of employee has some unique behavior:
  - Lawyers know how to sue.
  - Marketers know how to advertise.
  - Secretaries know how to take dictation.
  - Legal secretaries know how to prepare legal documents.



# An Employee class

**// A class to represent employees in general (20-page manual).**

```
public class Employee {  
    public int getHours() {  
        return 40;           // works 40 hours / week  
    }  
  
    public double getSalary() {  
        return 40000.0;      // $40,000.00 / year  
    }  
  
    public int getVacationDays() {  
        return 10;           // 2 weeks' paid vacation  
    }  
  
    public String getVacationForm() {  
        return "yellow";     // use the yellow form  
    }  
}
```

- **Exercise:** Implement class `Secretary`, based on the previous employee regulations. (Secretaries can take dictation.)

# Redundant Secretary class

**// A redundant class to represent secretaries.**

```
public class Secretary {  
    public int getHours() {  
        return 40;           // works 40 hours / week  
    }  
  
    public double getSalary() {  
        return 40000.0;      // $40,000.00 / year  
    }  
  
    public int getVacationDays() {  
        return 10;           // 2 weeks' paid vacation  
    }  
  
    public String getVacationForm() {  
        return "yellow";     // use the yellow form  
    }  
  
    public void takeDictation(String text) {  
        System.out.println("Taking dictation of text: " + text);  
    }  
}
```



# Desire for code-sharing

- `takeDictation` is the only unique behavior in `Secretary`.
- We'd like to be able to say:

*// A class to represent secretaries.*

```
public class Secretary {
```

**copy all the contents from the Employee class;**

```
    public void takeDictation(String text) {
```

```
        System.out.println("Taking dictation of text: " + text);
```

```
    }
```

```
}
```

# Inheritance

- **inheritance:** A way to form new classes based on existing classes, taking on their attributes/behavior.
  - a way to group related classes
  - a way to share code between two or more classes
- One class can *extend* another, absorbing its data/behavior.
  - **superclass:** The parent class that is being extended.
  - **subclass:** The child class that extends the superclass and inherits its behavior.
    - Subclass gets a copy of every field and method from superclass



# Inheritance syntax

```
public class name extends superclass {
```

- Example:

```
public class Secretary extends Employee {  
    ...  
}
```

- By extending `Employee`, each `Secretary` object now:
  - receives a `getHours`, `getSalary`, `getVacationDays`, and `getVacationForm` method automatically
  - can be treated as an `Employee` by client code (seen later)

# Improved Secretary code

// A class to represent secretaries.

```
public class Secretary extends Employee {  
    public void takeDictation(String text) {  
        System.out.println("Taking dictation of text: " + text);  
    }  
}
```

- Now we only write the parts unique to each type.
  - Secretary **inherits** getHours, getSalary, getVacationDays, and getVacationForm **methods** from Employee.
  - Secretary **adds** the takeDictation **method**.



# Implementing Lawyer

- Consider the following lawyer regulations:
  - Lawyers who get an extra week of paid vacation (a total of 3).
  - Lawyers use a pink form when applying for vacation leave.
  - Lawyers have some unique behavior: they know how to sue.
- Problem: We want lawyers to inherit *most* behavior from employee, but we want to replace parts with new behavior.

# Overriding methods

- **override:** To write a new version of a method in a subclass that replaces the superclass's version.
  - No special syntax required to override a superclass method. Just write a new version of it in the subclass.

```
public class Lawyer extends Employee {  
    // overrides getVacationForm method in Employee class  
    public String getVacationForm() {  
        return "pink";  
    }  
    ...  
}
```

- Exercise: Complete the `Lawyer` class.
  - (3 weeks vacation, pink vacation form, can sue)



# Lawyer class

```
// A class to represent lawyers.
public class Lawyer extends Employee {
    // overrides getVacationForm from Employee class
    public String getVacationForm() {
        return "pink";
    }

    // overrides getVacationDays from Employee class
    public int getVacationDays() {
        return 15;           // 3 weeks vacation
    }

    public void sue() {
        System.out.println("I'll see you in court!");
    }
}
```

- Exercise: Complete the `Marketer` class. Marketers make \$10,000 extra (\$50,000 total) and know how to advertise.

# Marketer class

**// A class to represent marketers.**

```
public class Marketer extends Employee {  
    public void advertise() {  
        System.out.println("Act now while supplies last!");  
    }  
  
    public double getSalary() {  
        return 50000.0;        // $50,000.00 / year  
    }  
}
```



# Levels of inheritance

- Multiple levels of inheritance in a hierarchy are allowed.
  - Example: A legal secretary is the same as a regular secretary but makes more money (\$45,000) and can file legal briefs.

```
public class LegalSecretary extends Secretary {  
    ...  
}
```

- Exercise: Complete the `LegalSecretary` class.

# LegalSecretary class

**// A class to represent legal secretaries.**

```
public class LegalSecretary extends Secretary {  
    public void fileLegalBriefs() {  
        System.out.println("I could file all day!");  
    }  
  
    public double getSalary() {  
        return 45000.0;        // $45,000.00 / year  
    }  
}
```