1.00 Lecture 13

Inheritance

Reading for next time: Big Java: sections 10.5-10.6

Inheritance

- **Inheritance allows you to write new classes based on existing (super or base) classes**
  - **Inherit super class methods and data**
  - **Add new methods and data**
- **This allows substantial reuse of Java code**
  - **When extending software, we often write new code that invokes old code (libraries, etc.)**
  - **We sometimes need to have old code invoke new code (even code that wasn't imagined when the old code was written), without changing (or even having) the old code**
    - **E.g., A drawing program must manage a new shape**
  - **Inheritance allows us to do this also**

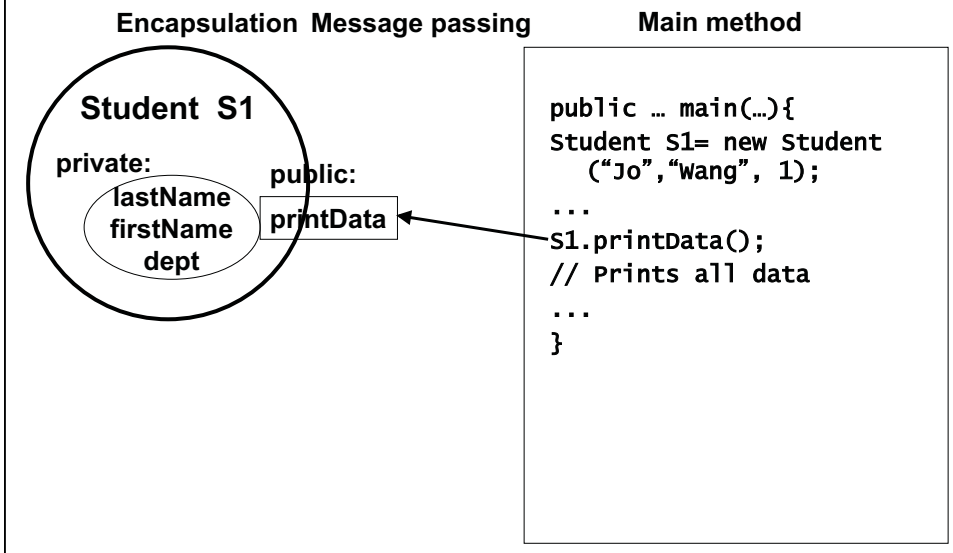
Access for inheritance

- Class may contain members (methods or data) of type:
  - Private:
    - Access only by class's methods
  - Protected
    - Access by:
      - Class's methods
      - Methods of inheriting classes, called subclasses or derived classes
      - Classes in same package
  - Package:
    - Access by methods of classes in same package
  - Public:
    - Access to all classes everywhere

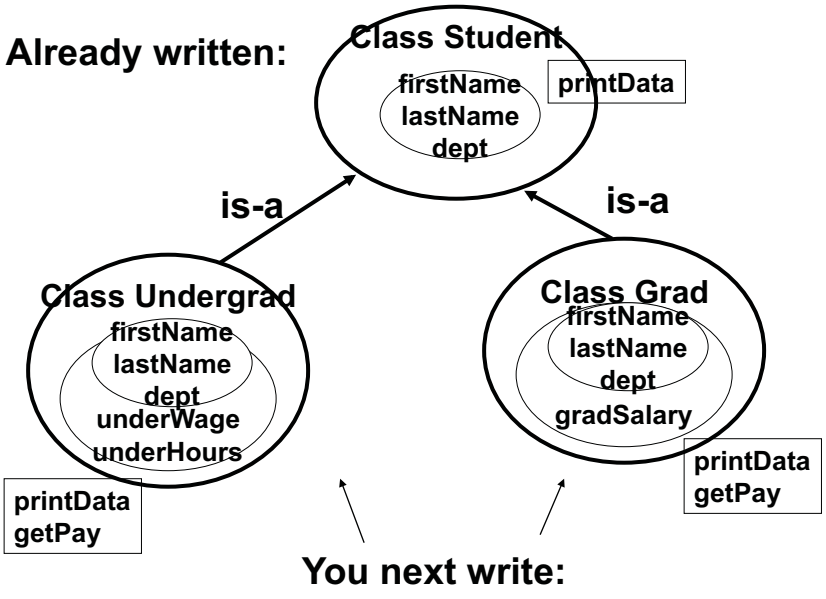
A Programming Project

- Department has system with Student class
  - Has extensive data (name, ID, courses, year, …) for all students that you need to use/display
  - Department wants to manage research projects better
    - Undergrads and grads have very different roles
      - Positions, credit/grading, pay, …
  - You want to reuse the Student class but need to add very different data and methods by grad/undergrad
    - Suppose Student was written 5 years ago by someone else without any knowledge that it might be used to manage research projects

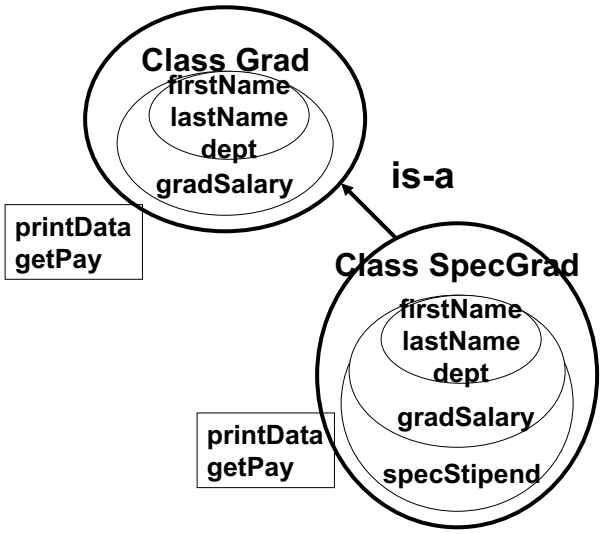
Classes and Objects



Inheritance



Inheritance, p.2



Exercise: Student class

- **Write a public `Student` class as a base or super class:**
  - **Two private variables: first name, last name**
  - **Constructor with two arguments**
  - **Void method `printData()` to print the first + last name:**

Exercise: Undergrad class

- **Write an `Undergrad` class as a derived or subclass:**
  - **Class declaration:**
    - `public class Undergrad extends Student`
  - **Add private double variables `underWage` and `underHours`**
  - **Constructor: *How many arguments does it have?***
    - **Invoke superclass constructor in 1st line of body:**
      `super( <arguments> )  // Use actual arguments`
    - **And then set the two new private variables as usual**
  - **Method `getPay()` returns `double underWage * underHours`**
  - **Method `printData()` prints `name` and `pay` (void)**
    - **Use superclass printData() method to print name in 1st line:**
      `super.printData();`
    - **Write a second line to `System.out.println` weekly pay**

Exercise: Grad class

- **Write a `Grad` class as a derived or subclass:**
  - **Class declaration: `extends Student`**
  - **Add private double variable `gradSalary`**
  - **Constructor: *How many arguments does it have?***
    - **Invoke superclass constructor in 1st line of body:**
      `super( <arguments> ) // Use actual args`
    - **And then set the new private variable**
  - **Method `getPay()` returns `double gradSalary`**
  - **Method `printData()` prints name and `pay` (void)**
    - **Use superclass `printData()` method to print name on 1st line**
    - **Write second line to print monthly pay**

Exercise: Special Grad class

- **Write `SpecGrad` class as derived or subclass:**
  - **Class declaration: `extends` _____**
  - **Add private double variable `specStipend`**
  - **Constructor: *How many arguments does it have?***
    - **Invoke superclass constructor: `super(<arguments>)`**
    - **And then set the new private variable**
  - **Method `getPay()` returns `double specStipend`**
  - **Method `printData()` prints name and `pay` (void)**
    - **Use superclass `printData()` method to print name and monthly salary (which is zero)**
    - **Write second line to print stipend**
  - **A special grad gets only a stipend, not a monthly salary. We'll discuss it in solutions.**

Exercise: main()

- **Download class `StudentTest`**
  - **It has only a `main()` method, which:**
    - **Creates `Undergrad ferd` at $12/hr for 8 hrs**
    - **Prints Ferd's data**
    - **Creates `Grad ann` at $1500/month**
    - **Prints Ann's data**
    - **Creates `SpecGrad mary` at $2000/term**
    - **Prints Mary's data**
    - **Creates an array of 3 `Students`**
    - **Sets array elements to `ferd, ann, mary`**
    - **Loops through the array and uses `printData()` on each `Student` object in the array to show their data.**
  - **What happens in the loop? Did you expect it?**

Main method

```
public class StudentTest {
 public static void main(String[] args) {
   Undergrad ferd= new Undergrad("Ferd", "Smith", 12.00, 8.0);
   ferd.printData();
   Grad ann= new Grad("Ann", "Brown", 1500.00);
   ann.printData();
   SpecGrad mary= new SpecGrad("Mary", "Barrett", 2000.00);
   mary.printData();
   System.out.println();

   // Polymorphism, and late binding
   Student[] team= new Student[3];
   team[0]= ferd;
   team[1]= ann;
   team[2]= mary;
   for (int i=0; i < 3; i++)
      team[i].printData();
    }
}
```

Java has internal table with the most specific object type and chooses the appropriate method at run time

Inheritance: Type set at runtime

- We can write a variation on StudentTest to prompt the user to pick a student type (undergrad, grad, special grad) with a JOptionPane, and then enter the needed data
  - The Undergrad, Grad or SpecGrad object would be placed in the team array
- When this program is compiled it has no way of knowing what kinds of Students will be added to the team array by a user
- When the program is run and objects are added, their types are dynamically tracked
  - In the team array, each object's specific printData() method will be invoked

StudentTest with input

```
import javax.swing.*;
public class StudentTestWithInput {
  public static void main(String[] args) {
    Student[] team = new Student[3];
      for (int i= 0; i < team.length; i++) {
       String type = JOptionPane.showInputDialog("Enter type");
       String fname = JOptionPane.showInputDialog("Enter fname");
       String lname = JOptionPane.showInputDialog("Enter lname");
       String payStr = JOptionPane.showInputDialog("Enter pay");
       double pay= Double.parseDouble(payStr);
       if (type.equals("Grad"))
         team[i]= new Grad(fname, lname, pay);
       else if (type.equals("SpecGrad"))
         team[i]= new SpecGrad(fname, lname, pay);
       else
         team[i]= new Undergrad(fname, lname, pay, 8.0);
      }
      // Polymorphism, and late binding
      for (int i = 0; i < 3; i++) {
       System.out.print(team[i].getClass()+ ":   ");
       team[i].printData(); } } }
```

Exercise

- **In class Grad:**
  - **Change printData() to use getPay() instead of explicitly printing gradSalary**
  - **Save/compile and run StudentTest**
  - **What happens?**
  - **Why?**

1.00 / 1.001 / 1.002 Introduction to Computers and Engineering Problem Solving
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