CS1001

Lecture 17

Overview

- Homework 3
- Project/Paper
- Object Oriented Design

Goals

- Learn Object-Oriented Design Methodologies

Assignments

- Brookshear: Ch 5.5, Ch 6.3/6.4, Ch 7 (especially 7.7) (Read)
- Read linked documents on these slides (slides will be posted in courseworks)

Objectives:

- Review the main OOP concepts:
  - inheritance
  - abstraction
  - encapsulation
  - polymorphism
- Get an appreciation for the complexity of object-oriented design.

What are OOP’s claims to fame?

- Better suited for team development
- Facilitates utilizing and creating reusable software components
- Easier GUI programming
- Easier program maintenance

OOP in a Nutshell:

- A program models a world of interacting objects.
- Objects create other objects and “send messages” to each other (in Java, call each other’s methods).
- Each object belongs to a class; a class defines properties of its objects. The data type of an object is its class.
- Programmers write classes (and reuse existing classes).

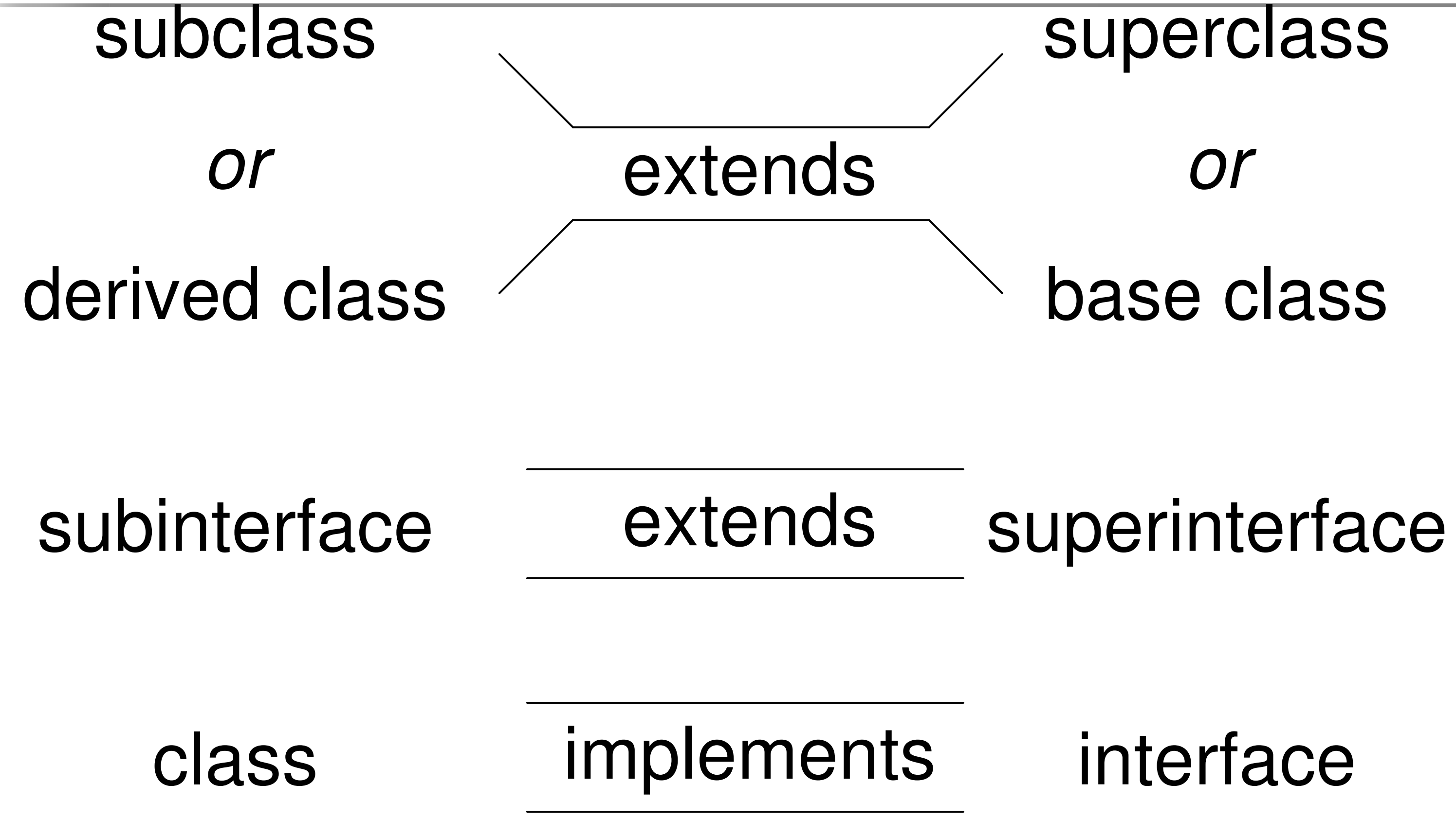
Main OOP Concepts:

- Inheritance
- Abstraction
- Encapsulation
- Polymorphism
- Event-driven computations

Inheritance

- A class can extend another class, inheriting all its data members and methods while redefining some of them and/or adding its own.
- A class can implement an interface, implementing all the specified methods.
- Inheritance implements the “is a” relationship between objects.

Inheritance (cont’d)



subclass

or

derived class

extends

superclass

or

base class

subinterface

extends

superinterface

class

implements

interface

Inheritance (cont'd)

- In Java, a subclass can extend only one superclass.
- In Java, a subinterface can extend one superinterface
- In Java, a class can implement several interfaces — this is Java's form of ***multiple inheritance***.

Inheritance (cont'd)

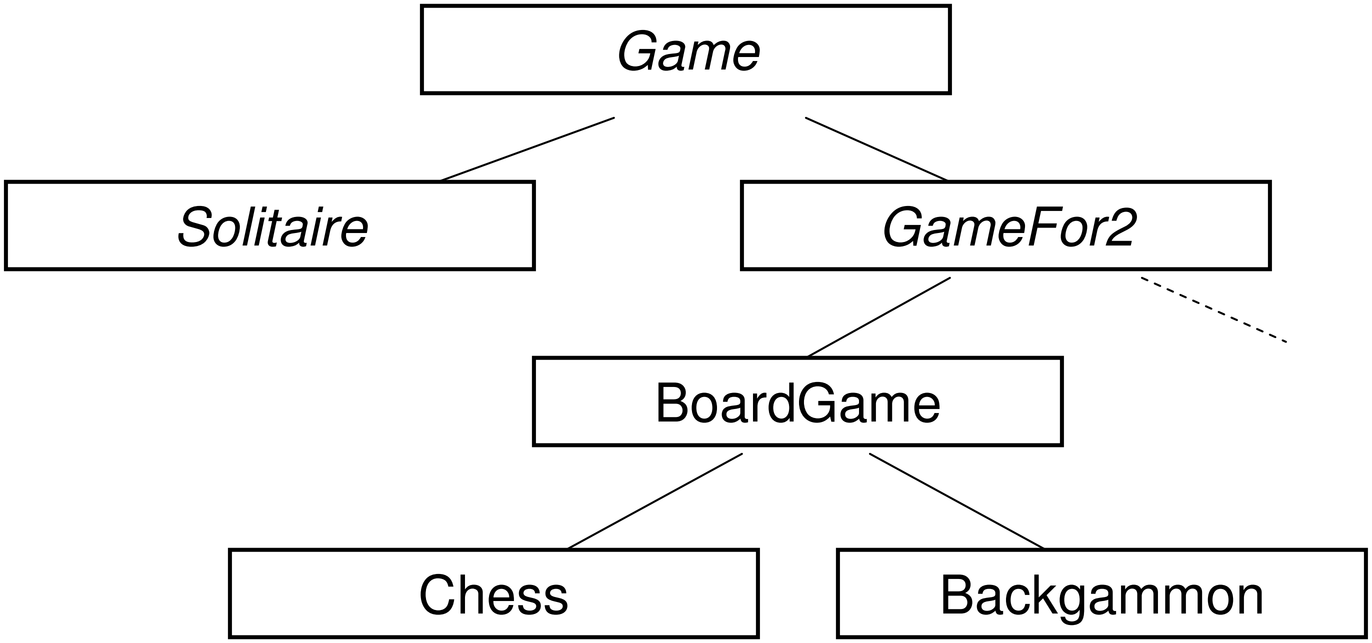
- An abstract class can have code for some of its methods; other methods are declared abstract and left with no code.
- An interface only lists methods but does not have any code.
- A concrete class may extend an abstract class and/or implement one or several interfaces, supplying the code for all the methods.

Inheritance (cont'd)

- Inheritance plays a dual role:
  - A subclass reuses the code from the superclass.
  - A subclass (or a class that implements an interface) inherits the data type of the superclass (or the interface) as its own secondary type.

Inheritance (cont'd)

- Inheritance leads to a hierarchy of classes and/or interfaces in an application:



Inheritance (cont'd)

- An object of a class at the bottom of a hierarchy inherits all the methods of all the classes above.
- It also inherits the data types of all the classes and interfaces above.
- Inheritance is also used to extend hierarchies of library classes, reusing the library code and inheriting library data types.

Inheritance (cont'd)

- Inheritance implements the "is a" relationship.
- Not to be confused with embedding (an object has another object as a part), which represents the "has a" relationship:

A sailboat is a boat

A sailboat has a sail

Quiz

- True or False? Inheritance is helpful for the following:

  - □ Team development ________
  - □ Reusable software ________
  - □ GUI programming ________
  - □ Easier program maintenance ________

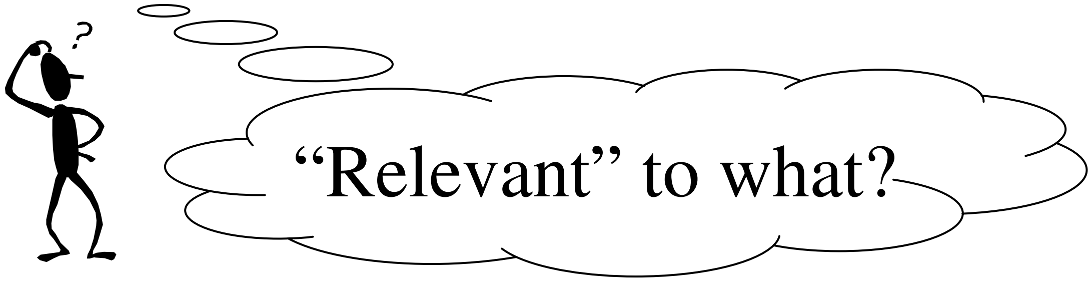
Answer

- True or False? Inheritance is helpful for the following:

  ☐ Team development ________
  ☑ Reusable software ________
  ☑ GUI programming ________
  ☐ Easier program maintenance ________

Abstraction

- Abstraction means ignoring irrelevant features, properties, or functions and emphasizing the relevant ones...



- ... relevant to the given project (with an eye to future reuse in similar projects).

Abstraction (cont’d)

- Example from javax.swing:
  public abstract class AbstractButton

```
Fields:
 protected ButtonModel model
 etc.
Methods:
 void addActionListener (ActionListener l);
 String getActionCommand();
 String getText()
 etc.
```

The data model that determines the button’s state

Apply to any button: “regular” button, a checkbox, a toggle button, etc.

Abstraction (cont'd)

```
java.lang.Object
  |
  +--java.awt.Component
        |
        +--java.awt.Container
              |
              +--javax.swing.JComponent
                    |
                    +--javax.swing.AbstractButton
```

Extends features of other abstract and concrete classes

Encapsulation

- Encapsulation means that all data members (*fields*) of a class are declared private. Some methods may be private, too.
- The class interacts with other classes (called the *clients* of this class) only through the class’s constructors and public methods.
- Constructors and public methods of a class serve as the *interface* to class’s clients.

Encapsulation (cont’d)

- Ensures that structural changes remain local:
  - Usually, the structure of a class (as defined by its fields) changes more often than the class’s constructors and methods.
  - Encapsulation ensures that when fields change, no changes are needed in other classes (a principle known as “locality”).

Quiz

- True or False? Abstraction and encapsulation are helpful for the following:

  □ Team development ________

  □ Reusable software ________

  □ GUI programming ________

  □ Easier program maintenance ________

Answer

- True or False? Abstraction and encapsulation are helpful for the following:

☑ Team development ________

☑ Reusable software ________

□ GUI programming ________

☑ Easier program maintenance ________

Polymorphism

- We often want to refer to an object by its primary, most specific, data type.
- This is necessary when we call methods specific to this particular type of object:

```
ComputerPlayer player1 = new ComputerPlayer();
HumanPlayer player2 = new HumanPlayer("Nancy", 8);
...
if ( player2.getAge () < 10 )
    player1.setStrategy (new Level1Strategy ());
```

Polymorphism (cont’d)

- But sometimes we want to refer to an object by its inherited, more generic type:

```
Player players[ ] = new Player[2];
players[0] = new ComputerPlayer();
players[1] = new HumanPlayer("Nancy”, 8);

game.addPlayer(players[0]);
game.addPlayer(players[1]);
```

Both ComputerPlayer and HumanPlayer implement Player

Polymorphism (cont'd)

- Why disguise an object as a more generic type?
  - To mix different related types in the same collection
  - To pass it to a method that expects a parameter of a more generic type
  - To declare a more generic field (especially in an abstract class) which will be initialized and "specialized" later.

Polymorphism (cont’d)

- Polymorphism ensures that the appropriate method is called for an object of a specific type when the object is disguised as a more generic type:

```
while ( game.notDone() )
{
   players[k].makeMove();
   k = (k + 1) % numPlayers;
}
```

The appropriate makeMove method is called for all players (e.g., for a HumanPlayer and a ComputerPlayer).

Polymorphism (cont’d)

- Good news: polymorphism is already supported in Java — all you have to do is use it properly.
- Polymorphism is implemented using a technique called ***late*** (or ***dynamic***) ***method binding***: which exact method to call is determined at run time.

OO Software Design

- Designing a good OOP application is a daunting task.
- It is largely an art: there are no precise rules for identifying classes, objects, and methods.
- Many considerations determine which classes should be defined and their responsibilities.
- A bad design can nullify all the potential OOP benefits.

OO Design (cont'd)

- A few considerations that determine which classes are defined and their responsibilities:
  - Manageable size
  - Clear limited functionality
  - Potential reuse
  - Support for multiple objects
  - The need to derive from a library class
  - The need to make a listener or to implement a particular interface
  - The need to collect a few data elements in one entity

Review:

- Name the main software development concerns that are believed to be addressed by OOP.
- Explain the dual role of inheritance.
- Can an interface extend another interface? If so, what does it mean?
- Can an interface extend a class? If so, what does it mean?
- Why do you think Java does not allow a class to extend several classes?

Review (cont’d):

- What is abstraction?
- Explain how encapsulation helps in software maintenance.
- Why sometimes objects end up disguised as objects of more generic types?
- What is polymorphism?