

Inheritance

CSE 114 INTRODUCTION TO OBJECT-ORIENTED PROGRAMMING

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Announcements

Today: Implementation inheritance

Reading assignment for this slide set: my notes

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Relationship between classes (objects)

'Has-a' relationship (object composition)

- A circle 'has a' point as its center.
- A point is composed into a circle.
- A circle is dependent on a point: if the point changes, the circle accordingly will change its location.
- Multiple objects could compose into an object, e.g., two points into a rectangle.

'Is-a' relationship (inheritance)

- A student 'is a' person. `Student` class as a subclass of `Person` class.
- `SavingsAccount` and `CheckingAccount` as subclasses of `Account` class.
- `Object` is a supertype of any class or interface in Java.

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Inheritance (implementation inheritance)

Interface: a mechanism used to provide a 'design' that can be inherited by subclasses.

Inheritance: a mechanism used to provide a 'design and implementation' including fields that can be inherited by subclasses.

See [Person.java](#), [Employee.java](#), [Manager.java](#)
(first without inheritance and then with inheritance)

- You can extend these three classes by having them implement the `Comparable` interface for greater than, less than, or equal to comparisons.

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The protected modifier

public: visible by any class

protected: visible by itself and its subclasses
(Rules about protected are more complicated than this, but this is good enough for now)

private: visible only by itself

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Shape interface (revisited)

Or, interface vs. inheritance revisited.

- Also will discuss single inheritance vs. multiple inheritance.

Shape.java: this interface contains the common design of all geometric shapes, the behavior part of the shapes!

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Shape interface (revisited)

UseShape.java: See how **Shape** is used in **UseShape**

- It was used much like a superclass (e.g., **Person**) was used in relation to a subclass (e.g., **Employee**), i.e., **Shape** is superinterface to **Circle** and **Rectangle** classes.

A class can **extend** only one other class in Java. Thus, we say that Java is said to support *single inheritance*. This is really *single implementation inheritance*.

A class can also (in addition to the one class it can extend) **implement** as many interfaces as it wants to. Thus, we say that Java is said to support *multiple inheritance*. This is really *multiple interface inheritance*.

So, Java supports *single implementation inheritance* but *multiple interface inheritance*.

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Summary

How many super classes can a Java class have?

One

How many super interfaces can a Java class have?

As many as it wants

How many super interfaces can a Java interface have?

As many as it wants

How does an interface inherit another interface?

Using the 'extends' keyword (not 'implements')

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Array of persons, employees, and managers

If you create an array with its element type `Person`, we can add `Employee` instances and `Manager` instances to the array in addition to `Person` instances.

- This array is said to be *polymorphic*!

It is acceptable to have these different types of objects in the same array because of the subtyping relationship among these types.

You can see the benefit of subtyping working for us as we write programs using objects that enjoy inheritance!

We have seen examples of this sort using `Shape` and `UseShape`. Although there we used an interface and classes, classes among themselves work in the same way as long as there are supertype/subtype relationships established among them.

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Object-oriented vs. function-oriented

'**Function-oriented**': function is the 'master' and objects or data are just being passed around between functions to be operated on. For example:

- `foo(a, b)`
- We did quite a bit of programming this way early in the semester before we started discussing objects. The static methods that we used then were like this although static methods themselves were part of an object, not a dynamic object but a static object. We are really talking about dynamic objects in this context.

Object-oriented: object is the 'master' and it 'owns' its data (fields) and behavior (methods):

- `a.foo(b)`
- Here `a` is really a dynamic object; `b` may or may not be an object.

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Software development process

1. Understand the problem in terms of its requirements
2. Design the software
 - What classes
 - What fields/methods in each class
 - What is static, dynamic?
 - What is private, protected, public?
 - Inheritance and composition relationships
3. Implement the design
4. Test the implementation

Often iterating over the steps as you debug your implementation and/or design.

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Test-first development

You should try to see how your design will be used by use code later. That is, see how `UseX` will be using your `X`.

Try to write some use code in the main of `UseX` to see how `X` will be used. That greatly helps you understand what `X` should provide.

In fact, you should write the use code (`UseX`) *first* before you write the base code (`X`).

We call this type of development *test first development*.

We did quite a bit of that this semester!

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Something to consider

A variable of supertype can hold a subtype object

A variable of subtype **cannot** hold a supertype object. Why not?

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