CSE 143 Java

Interfaces

Reading: Ch. 15.1.3

A Problem – Object Model for a Simulation

- Suppose we are designing the classes for a simulation game like the Sims, or Sim City
- We might want to model
  - People (office workers, police/firemen, politicians, ...)
  - Pets (cats, dogs, ferrets, lizards, ...)
  - Vehicles (cars, trucks, buses, ...)
  - Physical objects (buildings, streets, traffic lights, ...)
- Object model – use inheritance
  - Base classes for People, Pets, Vehicles, PhysicalThings, ...
  - Extended classes for specific kinds of things (Cat extends Pet, Dog extends Pet, Truck extends Vehicle...)

Making it Tick

- A time-based simulation has some sort of clock that ticks regularly
- On each tick, every object in the simulation needs to, for instance, update its state, maybe redraw itself, ...
- We would like to write methods in the simulation engine that can work with any object in the simulation

```
/** update the state of simulation object thing for one clock tick */
public void updateState(???   thing) {
    thing.tick( );
    thing.redraw( );
}
```

- Question: What is the type of parameter *thing* in this method?

Type Compatibility

- We want to be able to write something like

```
public void updateState(SimThing thing) { ... }
```

  where "SimThing" is a type that is compatible with Cats, Cars, People, Buildings. How?
- Could create an additional superclass SimThing and have People, Pets, Vehicles, PhysicalThings, ..., all extend it, but:
  - People, Pets, etc. don't have a real "is-a" relationship
  - What if we wanted to have other polymorphic methods that, for example, only apply to breathing things?
  - Deep inheritance hierarchies are brittle, hard to modify

Solution – Interfaces

- We want a way to create a type SimThing independently of the simulation actor class hierarchies, then tag each of those classes so they can be treated as SimThings
- Solution: create a Java ***interface*** to define type SimThing
- Declare that the appropriate classes ***implement*** this interface

SimThing Interface

- Interface declaration

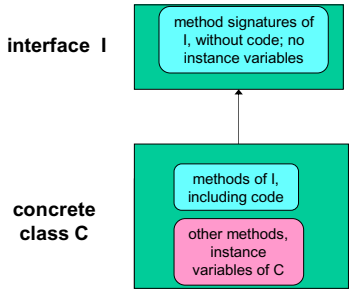
```
/** Interface for all objects involved in the simulation */
public interface SimThing {
    public void tick( );
    public void redraw( );
}
```

- Class declaration using the interface

```
/** Base class for all Pets in the simulation */
public class Pet implements SimThing {
    /** tick method for Pets */
    public void tick( ) { ... }
    /** redraw method for Pets */
    public void redraw( ) { ... }
    ...
}
```


Interfaces and Implements

- A Java *interface* declares a set of method signatures
  - i.e., says what behavior exists
  - Does not say how the behavior is implemented
    i.e., does not give code for the methods
  - Does not describe any state (but may include "final" constants)
- A concrete class that implements an interface
  - Contains "implements *InterfaceName*" in the class declaration
  - Must provide implementations (either directly or inherited from a superclass) of all methods declared in the interface
- An abstract class can also implement an interface
  - Can optionally have implementations of some or all interface methods



Implements vs. Extends

- Both describe an "is-a" relation
- If B *implements* interface A, then B inherits the (abstract) method signatures in A
- If B *extends* class A, then B inherits everything in A, which can include method code and instance variables as well as abstract method signatures
- Sometimes people distinguish "interface inheritance" from "code" or "class inheritance"
  - Specification vs implementation
  - Informally, "inheritance" is sometimes used to talk about the superclass/subclass "extends" relation only

Classes, Interfaces, and Inheritance

- A class
  - Extends exactly one other class (which defaults to Object if "extends ..." does not appear in the class definition)
  - Implements zero or more interfaces (no limit)
- Interfaces can also extend other interfaces (superinterfaces)

```
Interface ScaryThing extends SimThing { ... }
```

  - Mostly found in larger libraries and systems
  - A concrete class implementing an extended interface must implement all methods in that interface and (transitively) all interfaces that it extends

What is the Type of an Object?

- Every interface or class declaration defines a new ***type***
- An instance of a class named *Example* has all of these types:
  - The named class (*Example*)
  - Every superclass that *Example* extends directly or indirectly (including Object)
  - Every interface (including superinterfaces) that Example implements
- The instance can be used anywhere one of its types is appropriate
  - As variables, as parameters and arguments, as return values

Benefits of Interfaces

- May be hard to see in small systems, but in large ones...
- Better model of application domain
  - Avoids inappropriate uses of inheritance to get polymorphism
- More flexibility in system design
  - Can isolate functionality in separate interfaces – better cohesion, less tendency to create monster "kitchen sink" interfaces or classes
  - Allows multiple abstractions to be mixed and matched as needed

Interfaces vs Abstract Classes

- Both of these specify a type
- Interface
  - Pure specification
  - No method implementation (code), no instance variables, no constructors
- Abstract class
  - Method specification plus, optionally:
    - Partial or full default method implementation
    - Instance variables
    - Constructors (called from subclasses using super)
- Which to use?

Abstract Classes vs. Interfaces

Abstract Class Advantages

- Can include instance variables
- Can include a default (partial or complete) implementation, as a starter for concrete subclasses
- Wider range of modifiers and other details (static, etc.)
- Can specify constructors, which subclasses can invoke with *super*
- Interfaces with many method specifications are tedious to implement (implementations can't be inherited)

Interface Advantages

- A class can extend *at most one* superclass (abstract or not)
- By contrast, a class (and an interface) can implement any number of super-interfaces
- Helps keep state and behavior separate
- Provides fewer constraints on algorithms and data structures

A Design Strategy

- These rules of thumb seem to provide a nice balance for designing software that can evolve over time:
  (Might be overkill for some CSE 143 projects)
  - Any major type should be defined in an interface
  - If it makes sense, provide a default implementation of the interface – can be abstract or concrete
  - Client code can choose to either extend the default implementation, overriding methods that need to be changed, or implement the complete interface directly (needed if the class already has a specified superclass)
- This pattern occurs frequently in the standard Java libraries