Quentin Tarantino's "Learn Java in a Minute"

OBJECT-ORIENTED PROGRAMMING

Abstract Classes and Interfaces

Lecture #4

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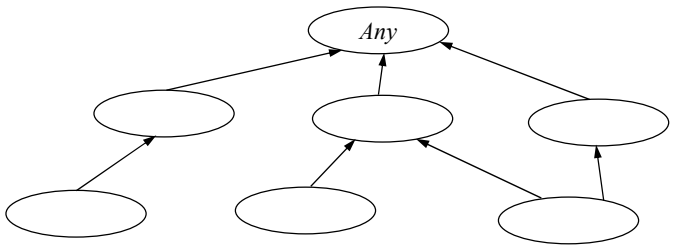
Class hierarchy

- By class inheritance we can model class hierarchy



- Is it good to have one class hierarchy in the system?
  - All classes derive from *Any*, i.e. "**classes can be of any type**"
  - What is in the top of the hierarchy?

Advantages of class hierarchy

- We can use **polymorphic references to any object** in the system
  - Reusable functions work with any objects of the system
  - We do not need to rewrite functions
    - For example method `sell()` of class `Shop` works with both `Article` and `DiscountArticle`
- In the top of the hierarchy we can specify **general (universal) properties** of all objects in the system, e.g.
  - Clone – duplicating objects
  - Copy – copying content of the object to another
  - Equal – field-by-field comparison of the objects

Subtype example

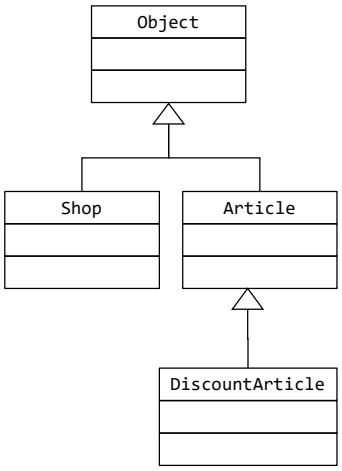
- Class `java.util.Vector` has reusable method **`void`** `addElement(Object obj)`

```
public class StringSet {
  private Vector elements;
  public void insert(String s) {
    this.elements.addElement(s);
  }
}
```

Why can we use a `String` where an `Object` is expected?

Building class hierarchy

- Java (and other object-oriented languages too) implements general inheritance structure
- **Any class that does not include an inheritance clause, implicitly inherits form class `Object`**
- Class `Object` is a kernel class of Java and specifies some universal features of all objects
- In our project `Shop` and `Article` classes implicitly inherit from `Object` class



Abstract class

- Some classes describe an **abstract** idea rather than a **specific** one
- Abstract class is **declared as `abstract` and cannot be instantiated**
- Abstract class is just to **guarantee** that its closed subclasses **must** override its abstract methods
- Abstract class declares **abstract methods**
  - They do not have body, they just declare an abstract feature, which must be overridden in subclasses

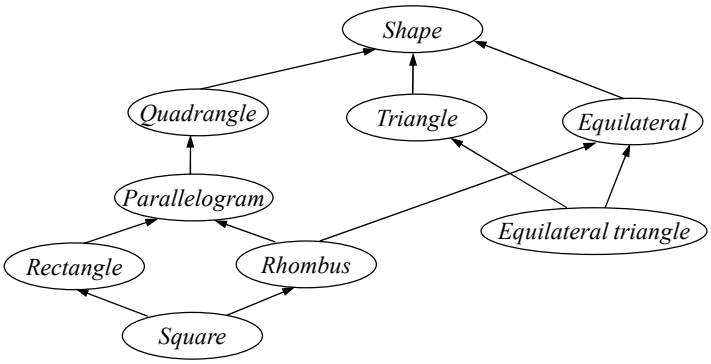
```
public abstract class ClassName {

}
```


Constructors in abstract class

- Do we need a constructor for abstract class?
  - Remember the inheritance: At the beginning of each constructor of subclass the default constructor of superclass is called
- **Do not define public** constructors in abstract classes
  - Constructors with public are for types that can be instantiated. Abstract types can never be instantiated.
- **Do define a protected** constructor in abstract classes
  - The base class can perform initialization tasks when instances of a derived class are created

A class hierarchy abstraction



- What are the supertypes of *Square*?
- What are the subtypes of *Parallelogram*?

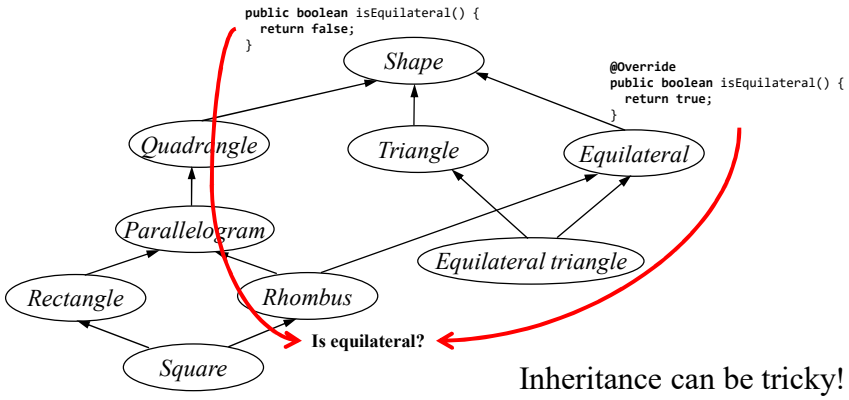
Reusing implementation

- All shapes reuse (inherit from `Shape`) an `isEquilateral()` method

```
public class Shape {
  ...
  public boolean isEquilateral() { return false; }
  ...
}

public class Equilateral extends Shape {
  ...
  @Override
  public boolean isEquilateral() { return true; }
  ...
}
```

Is a *Rhombus* equilateral?



Inheritance can be tricky!

Solutions of multiple inheritance problems

- Java, C#
  - Allow multiple supertypes using interfaces, but only one implementation
  - Pro: Safe and simple
  - Con: Limits reuse
- C++
  - Allows it, let programmers shoot themselves if they want

Interface

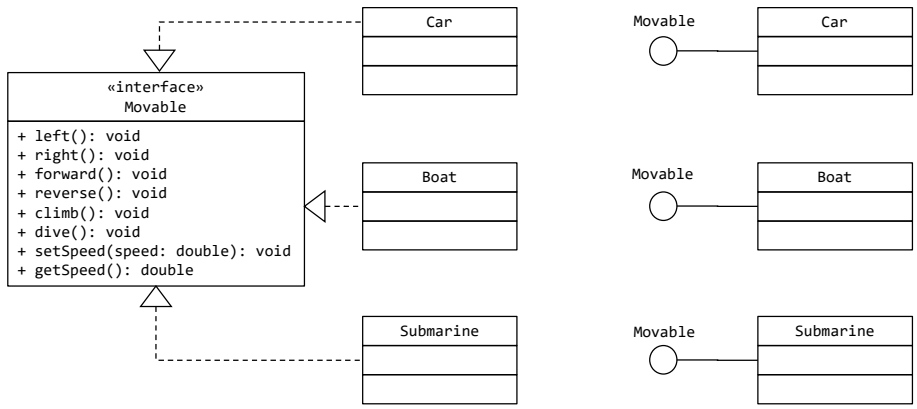
- **An interface is the set of methods one object must implement**
- In many ways, **interface** is very similar to **abstract class**

```
public interface InterfaceName {

}
```

- Unlike abstract class which can also contain non-abstract methods, interface contains **only** abstract methods and constants

Interfaces in UML



Extending interface

- An object can have **many** interfaces
  - Essentially, an interface is a subset of all the methods that an object implements
  - We can inherit only **one class**, but we can implement **many interfaces**

```
public class A extends B implements I1, I2, I3 {
  ...
}
```

- Interface can inherit from another interface

```
public interface A {
  void f();
}
public interface B extends A {
  void g();
}
public class C implements B {
  @Override
  public void f() { ... }
  @Override
  public void g() { ... }
}
```

Class `C` must implement method `g()` from interface `B` and also method `f()` from inherited interface `A`

Interfaces as types

- **A type is a specific interface of an object**
- Different objects can have the same type and the same object can have many different types
- An object is known by other objects only through its interface
- Interface is an implementation of subtyping in object-oriented language
  - Describes when one object can be used in place of another object

Abstract class vs interface

- Why not use abstract class instead of interface?
  - In **C++**, a class can inherit multiple superclasses which is known **multiple inheritance**
  - **Java** does not allow multiple inheritance and a class can only have a single inheritance
- In **interface**, you **cannot** include **non-abstract methods** at all
  - Classes that implement the interface **must override every method**
- In **abstract class**, you can **mix non-abstract** and **abstract methods** together
  - Subclasses could reuse some non-abstract methods without override

Interface like abstract class

- If a class implements an interface, you must override the interface's methods in the class
- You cannot create instances from an interface by using `new` operator
- Interface can be a type as well as class
- The purpose of creating interface is because of **polymorphism**

Interface unlike abstract class

- You can have multiple interfaces in one class
- Interface is **not** designed to be **superclass**, but interface is designed to **add some behaviors** to a class
- A relationship between **(abstract) class and class** is a **strong relationship** and it is known as **IS-A relationship**
  - "A duck is a bird" – It clearly means the duck is really a bird, so the bird can be a superclass of a duck and it could be either concrete or abstract class
- A relationship between **class and interface** is a **weak relationship** and it is known as **IS-KIND-OF relationship**
  - "A duck is flyable" – Flyable can never ever be the superclass of the duck, it just means this duck can fly, so flyable is interface

Conventions for interfaces

- Because the interface is just designed to add some behaviors or some features to classes, usually it contains only one or two general methods

```
public interface Runnable {
  void run();
}
```

- The reason for this is that interface is not a superclass, so it does not specify who can use its methods. Generally, **its method might be used by everyone**
- By Java code convention, the name of interface is usually **adjective**, because adjective adds some meaning to a noun
  - `Runnable`, `Comparable`, `Clonable`, `Accessible`
- The interface names for event driven listener are usually ended with `Listener`
  - `ActionListener`, `MouseMotionListener`, `KeyListener`
- Some programmers use the "I" prefix for interface names (Hungarian notation)
  - `ICommand`, `IMessage`