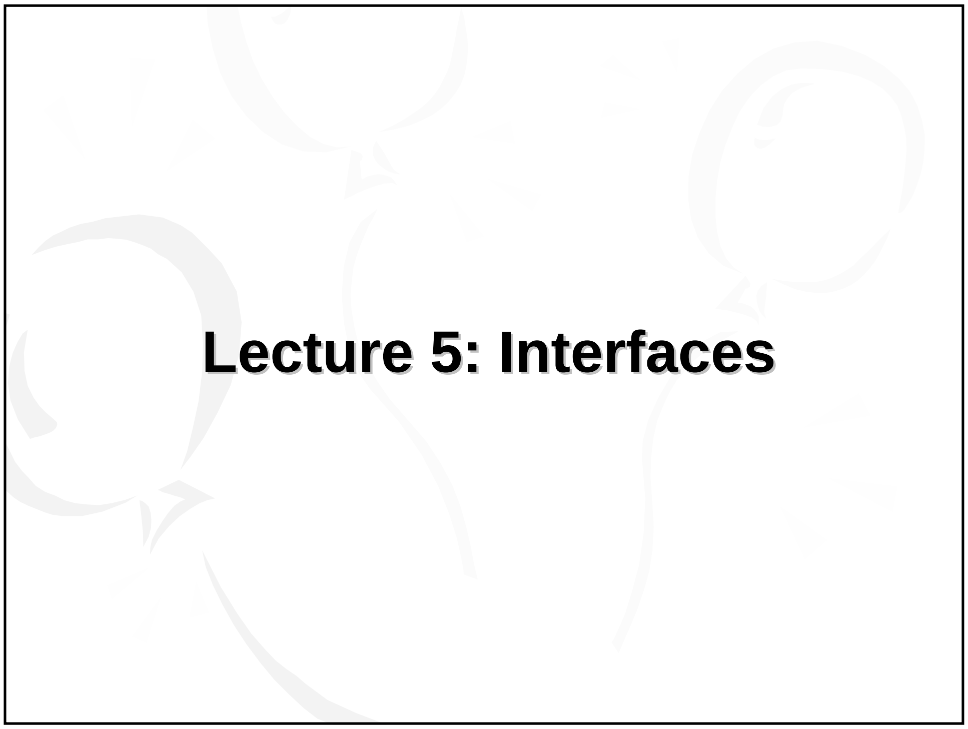
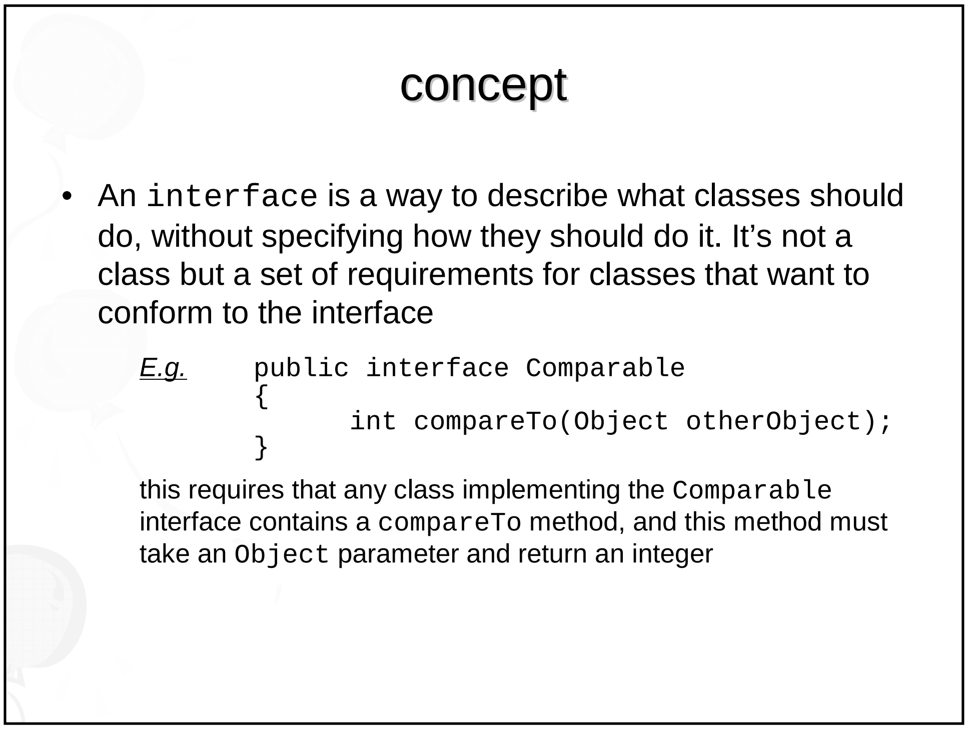


Lecture 5: Interfaces

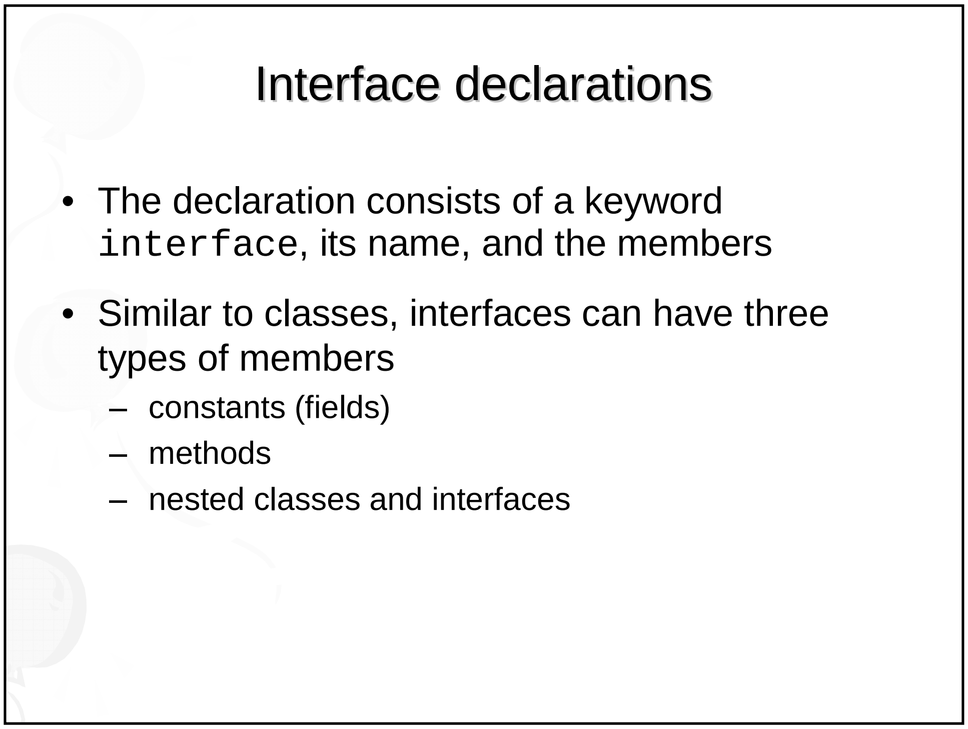


concept

- An `interface` is a way to describe what classes should do, without specifying how they should do it. It’s not a class but a set of requirements for classes that want to conform to the interface

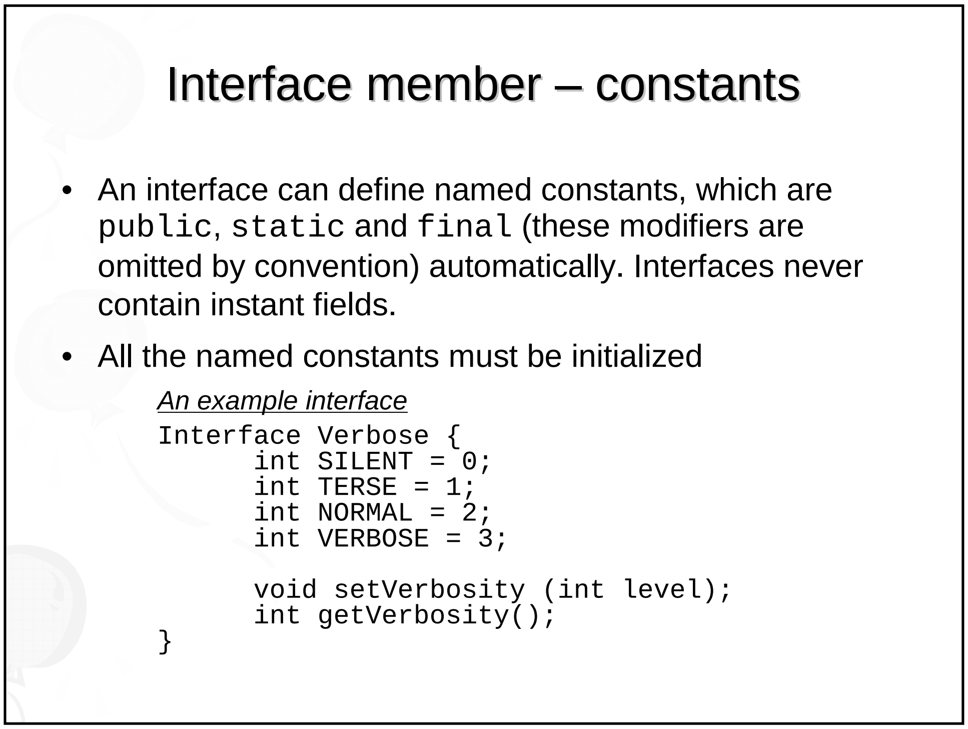
  _E.g._
  ```
  public interface Comparable
  {
        int compareTo(Object otherObject);
  }
  ```

  this requires that any class implementing the `Comparable` interface contains a `compareTo` method, and this method must take an `Object` parameter and return an integer



Interface declarations

- The declaration consists of a keyword `interface`, its name, and the members
- Similar to classes, interfaces can have three types of members
  - constants (fields)
  - methods
  - nested classes and interfaces



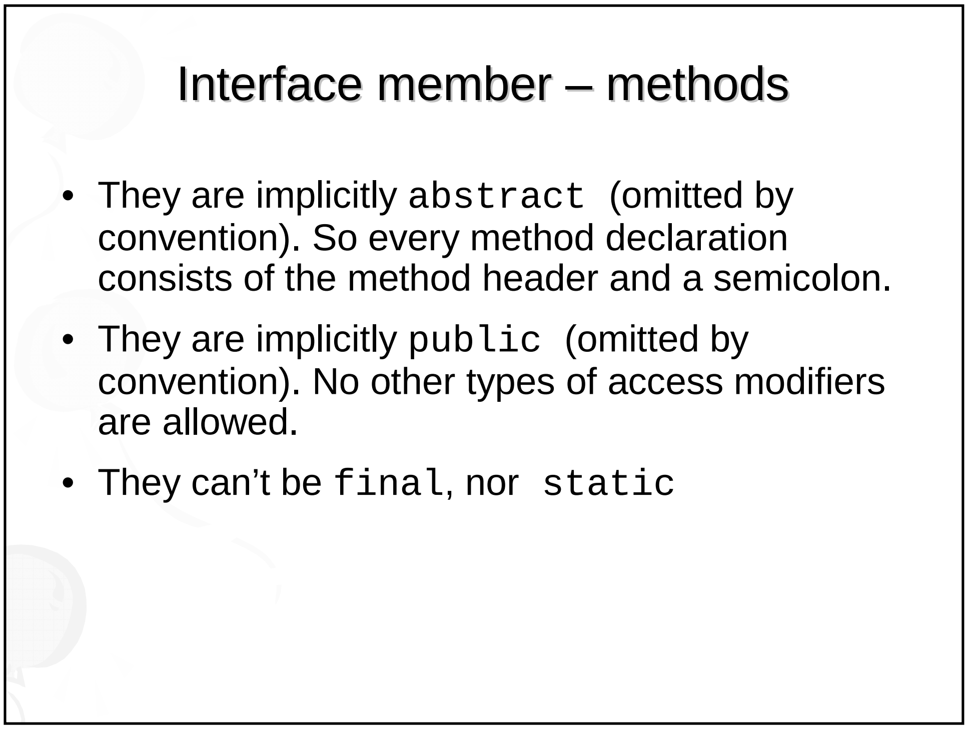
Interface member – constants

- An interface can define named constants, which are `public`, `static` and `final` (these modifiers are omitted by convention) automatically. Interfaces never contain instant fields.
- All the named constants must be initialized

An example interface

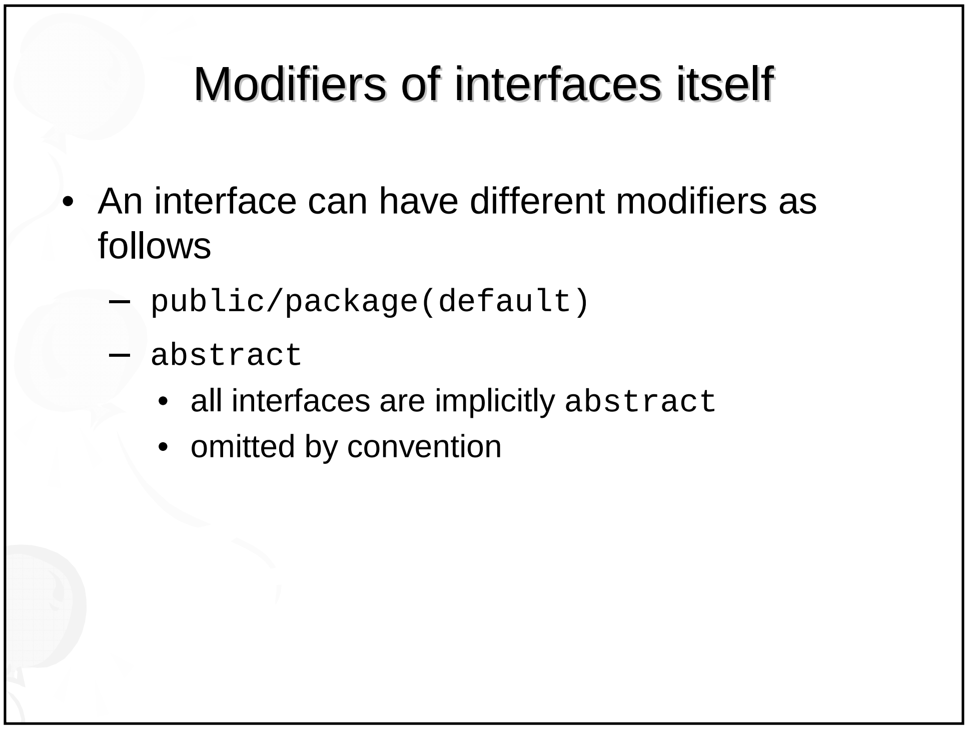
```
Interface Verbose {
      int SILENT = 0;
      int TERSE = 1;
      int NORMAL = 2;
      int VERBOSE = 3;

      void setVerbosity (int level);
      int getVerbosity();
}
```



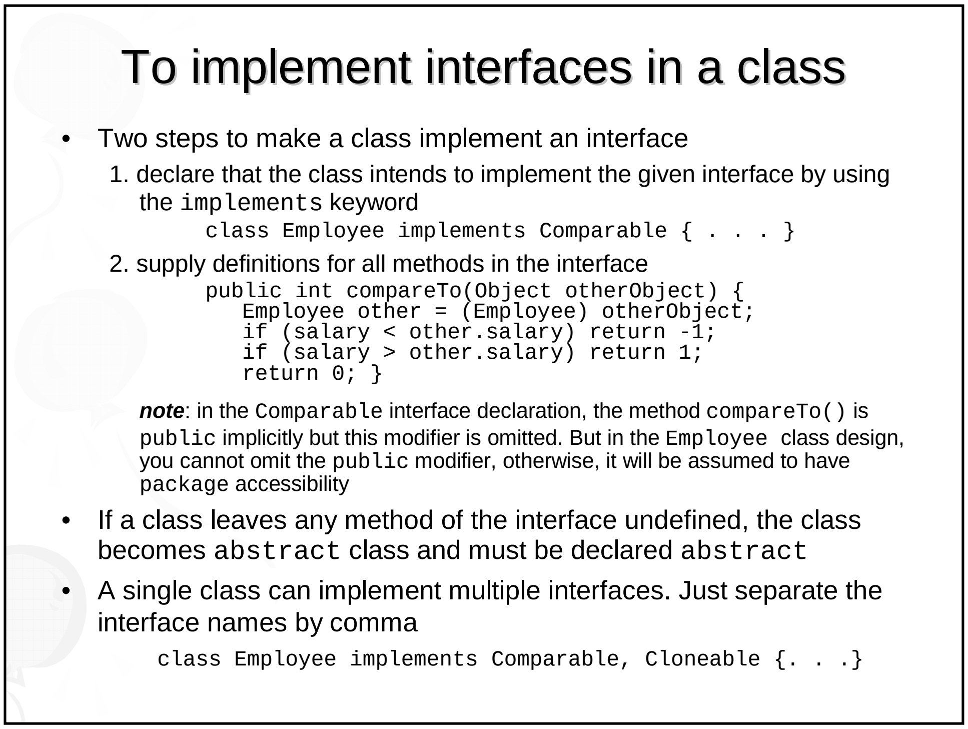
Interface member – methods

- They are implicitly `abstract` (omitted by convention). So every method declaration consists of the method header and a semicolon.
- They are implicitly `public` (omitted by convention). No other types of access modifiers are allowed.
- They can’t be `final`, nor `static`



Modifiers of interfaces itself

- An interface can have different modifiers as follows
  - `public/package(default)`
  - `abstract`
    - all interfaces are implicitly `abstract`
    - omitted by convention



To implement interfaces in a class

- Two steps to make a class implement an interface
  1. declare that the class intends to implement the given interface by using the `implements` keyword

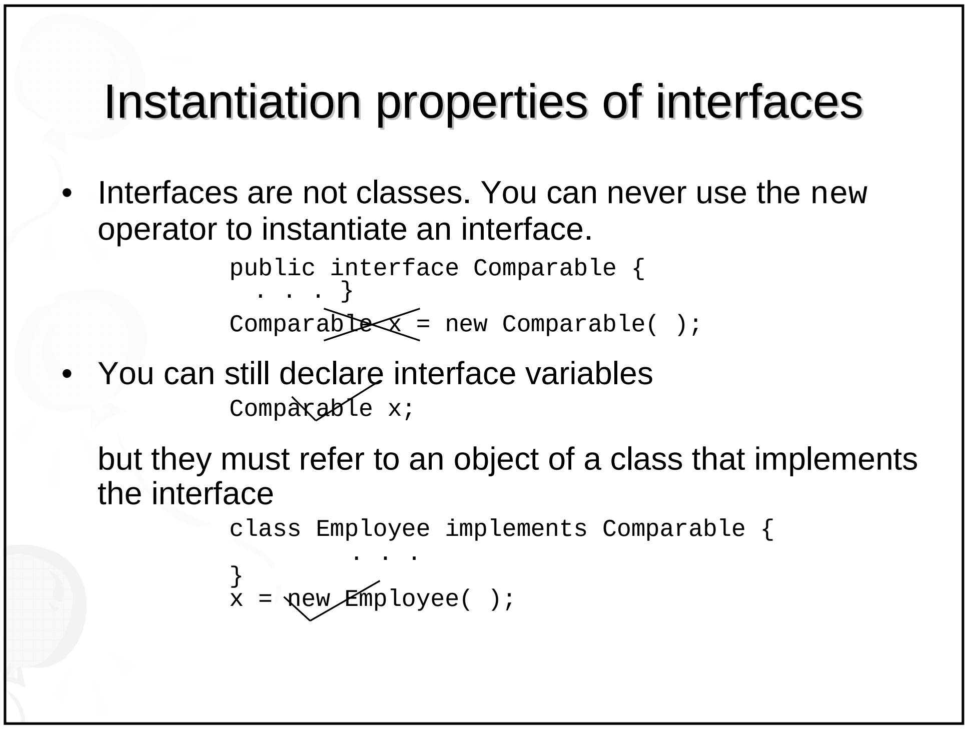
     ```
     class Employee implements Comparable { . . . }
     ```

  2. supply definitions for all methods in the interface

     ```
     public int compareTo(Object otherObject) {
        Employee other = (Employee) otherObject;
        if (salary < other.salary) return -1;
        if (salary > other.salary) return 1;
        return 0; }
     ```

  note: in the `Comparable` interface declaration, the method `compareTo()` is `public` implicitly but this modifier is omitted. But in the `Employee` class design, you cannot omit the `public` modifier, otherwise, it will be assumed to have `package` accessibility
- If a class leaves any method of the interface undefined, the class becomes `abstract` class and must be declared `abstract`
- A single class can implement multiple interfaces. Just separate the interface names by comma

  ```
  class Employee implements Comparable, Cloneable {. . .}
  ```



Instantiation properties of interfaces

- Interfaces are not classes. You can never use the `new` operator to instantiate an interface.

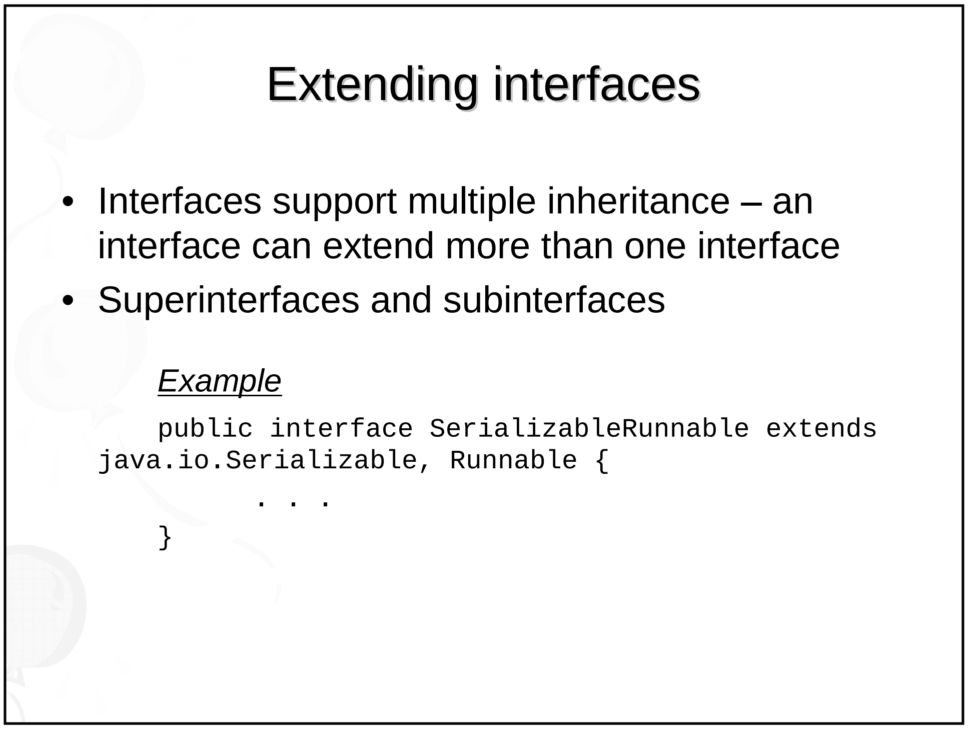
  ```
  public interface Comparable {
    . . . }
  Comparable x = new Comparable( ); ✗
  ```

- You can still declare interface variables

  ```
  Comparable x; ✓
  ```

  but they must refer to an object of a class that implements the interface

  ```
  class Employee implements Comparable {
          . . .
  }
  x = new Employee( ); ✓
  ```

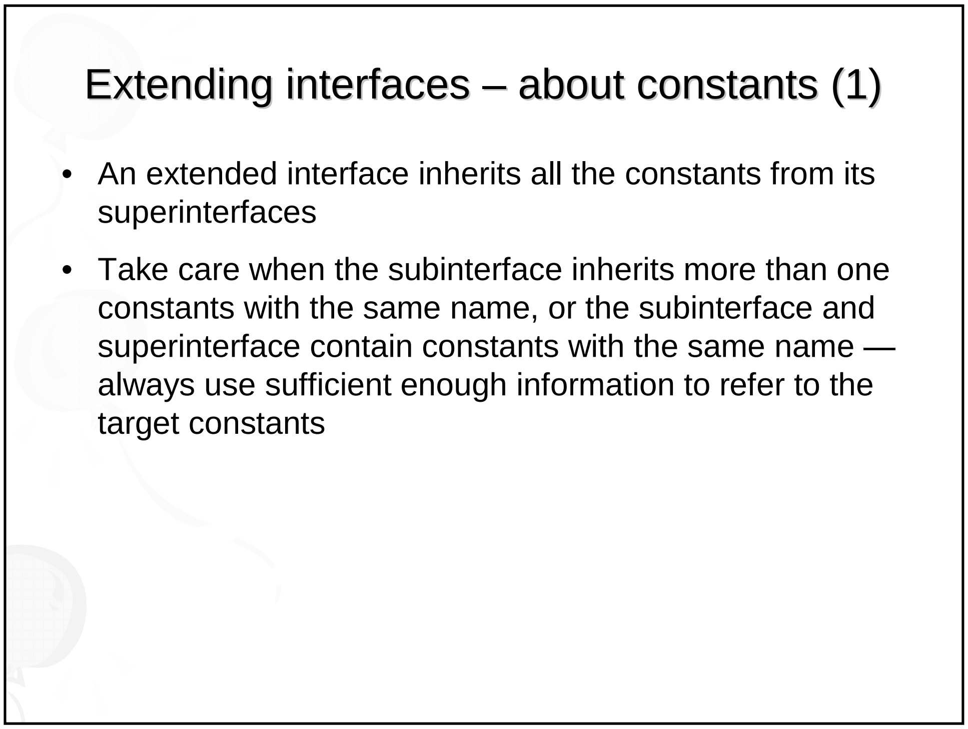


Extending interfaces

- Interfaces support multiple inheritance – an interface can extend more than one interface
- Superinterfaces and subinterfaces

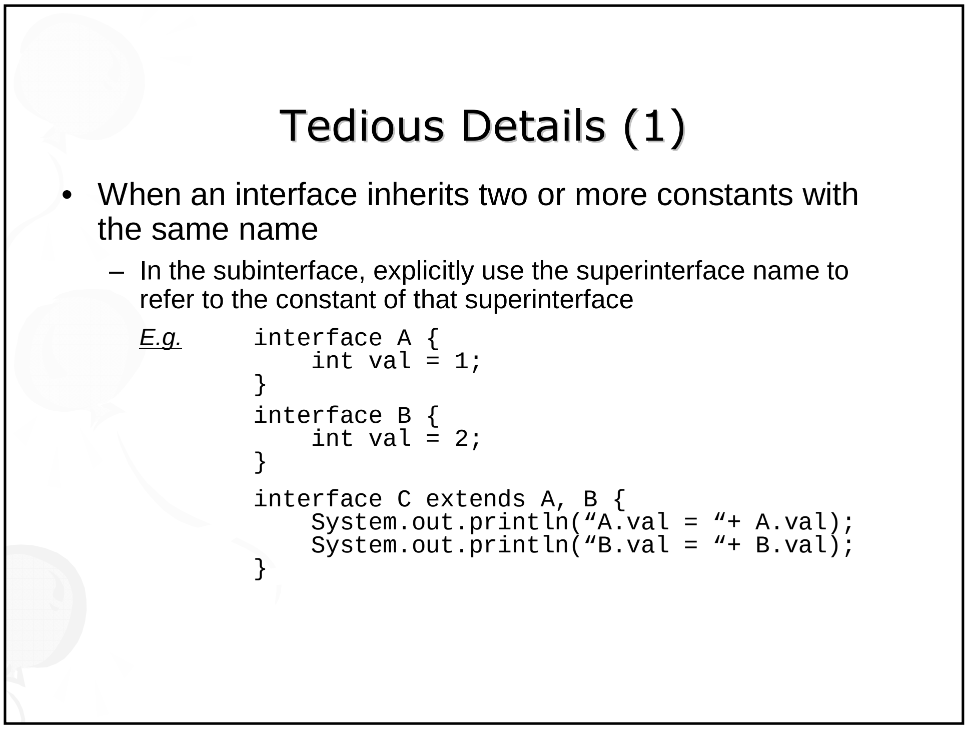
Example

```
    public interface SerializableRunnable extends
java.io.Serializable, Runnable {
          . . .
    }
```



Extending interfaces – about constants (1)

- An extended interface inherits all the constants from its superinterfaces
- Take care when the subinterface inherits more than one constants with the same name, or the subinterface and superinterface contain constants with the same name — always use sufficient enough information to refer to the target constants

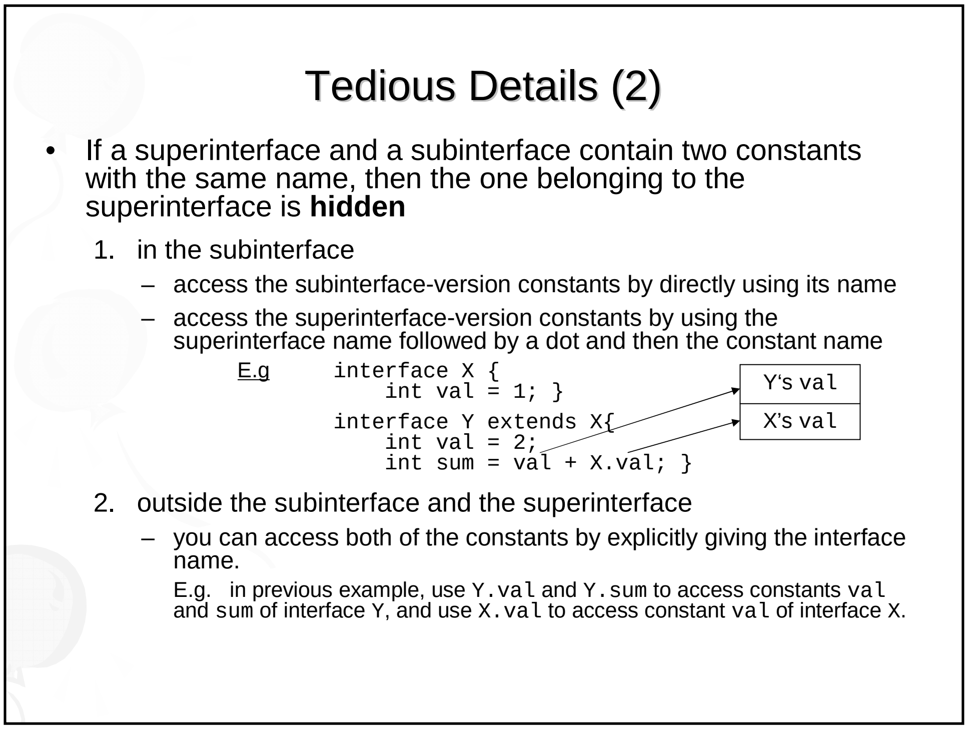


Tedious Details (1)

- When an interface inherits two or more constants with the same name
  - In the subinterface, explicitly use the superinterface name to refer to the constant of that superinterface

E.g.

```
interface A {
    int val = 1;
}
interface B {
    int val = 2;
}
interface C extends A, B {
    System.out.println(“A.val = “+ A.val);
    System.out.println(“B.val = “+ B.val);
}
```



Tedious Details (2)

- If a superinterface and a subinterface contain two constants with the same name, then the one belonging to the superinterface is **hidden**

1. in the subinterface
   - access the subinterface-version constants by directly using its name
   - access the superinterface-version constants by using the superinterface name followed by a dot and then the constant name

E.g

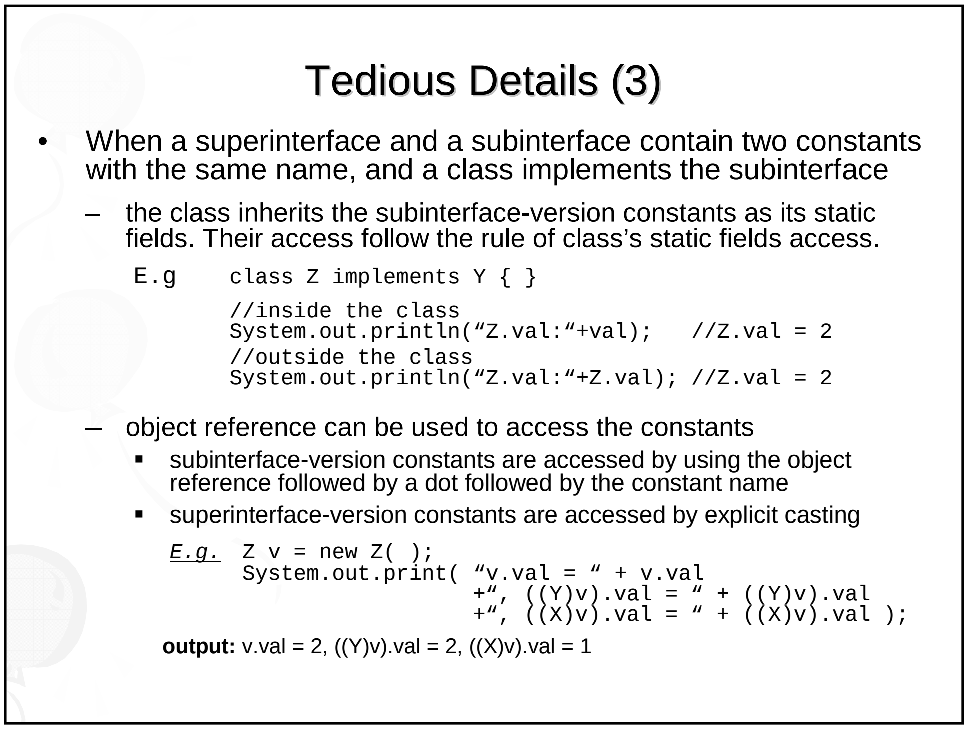
```
interface X {
    int val = 1; }
interface Y extends X{
    int val = 2;
    int sum = val + X.val; }
```

Y‘s `val`

X’s `val`

2. outside the subinterface and the superinterface
   - you can access both of the constants by explicitly giving the interface name.

     E.g. in previous example, use `Y.val` and `Y.sum` to access constants `val` and `sum` of interface `Y`, and use `X.val` to access constant `val` of interface `X`.



Tedious Details (3)

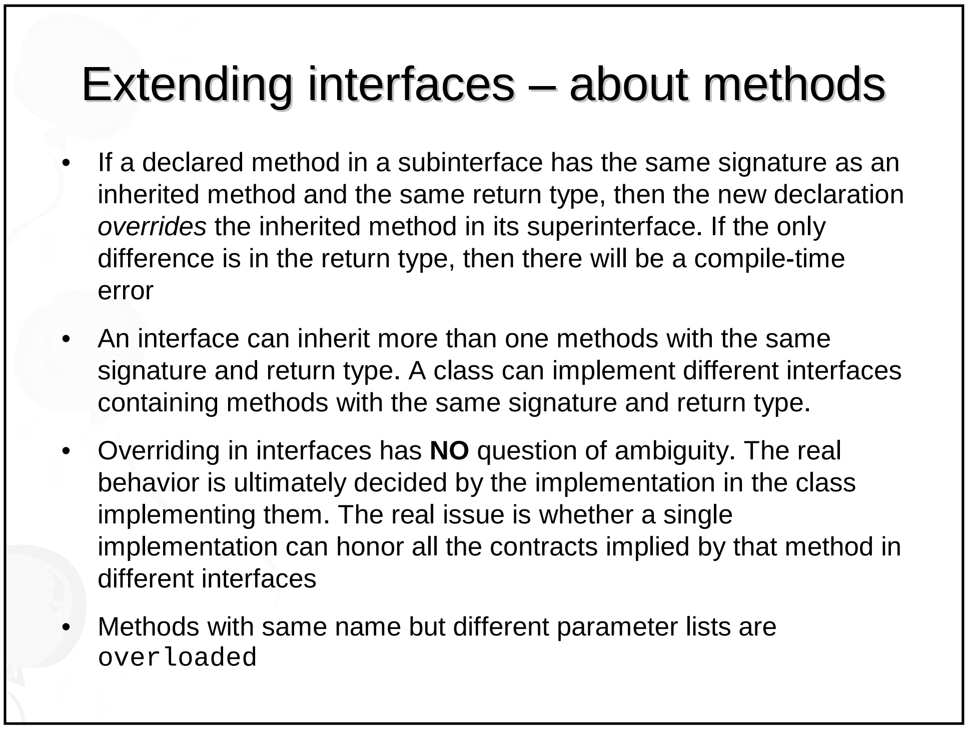
- When a superinterface and a subinterface contain two constants with the same name, and a class implements the subinterface
  - the class inherits the subinterface-version constants as its static fields. Their access follow the rule of class's static fields access.

```
E.g    class Z implements Y { }
       //inside the class
       System.out.println("Z.val:"+val);   //Z.val = 2
       //outside the class
       System.out.println("Z.val:"+Z.val); //Z.val = 2
```

  - object reference can be used to access the constants
    - subinterface-version constants are accessed by using the object reference followed by a dot followed by the constant name
    - superinterface-version constants are accessed by explicit casting

```
E.g.  Z v = new Z( );
      System.out.print( "v.val = " + v.val
                        +", ((Y)v).val = " + ((Y)v).val
                        +", ((X)v).val = " + ((X)v).val );
```

output: v.val = 2, ((Y)v).val = 2, ((X)v).val = 1



Extending interfaces – about methods

- If a declared method in a subinterface has the same signature as an inherited method and the same return type, then the new declaration *overrides* the inherited method in its superinterface. If the only difference is in the return type, then there will be a compile-time error
- An interface can inherit more than one methods with the same signature and return type. A class can implement different interfaces containing methods with the same signature and return type.
- Overriding in interfaces has **NO** question of ambiguity. The real behavior is ultimately decided by the implementation in the class implementing them. The real issue is whether a single implementation can honor all the contracts implied by that method in different interfaces
- Methods with same name but different parameter lists are `overloaded`

Why using interfaces?

See the examples:

Interface: `Shape` (Shape.java)

Class implementing this interface: `Point` (Point.java)

Subclasses of `Point`: `Circle` (Circle.java), `Cylinder` (Cylinder.java)

Test class: Test.java

a The usefulness of interfaces goes far beyond simply publishing protocols for other programmers. Any function can have parameters that are of interface type. Any object of a class that implements the interface may be passed as an argument.

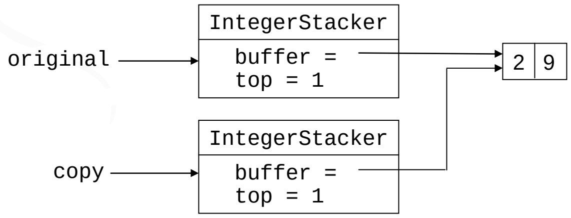
Marker interfaces and object cloning

- A marker (tagging) interface has neither methods nor constants, its only purpose is to allow the use of `instanceof` in a type inquiry. `Cloneable` interface is such an example.
- Object clone: a clone method returns a new object whose initial state is a copy of the current state of the object on which `clone` was invoked. Subsequent changes to the new clone object should not affect the state of the original object.
- Three factors in writing a `clone` method
  - The empty Cloneable interface. You must implement it to provide a clone method that can be used to clone an object
  - The clone method implemented by the Object class performs a simple clone by copying all fields of the original object to the new object
  - The CloneNotSupportedException, which can be used to signal that a class's clone method shouldn't have been invoked

Object cloning (1)

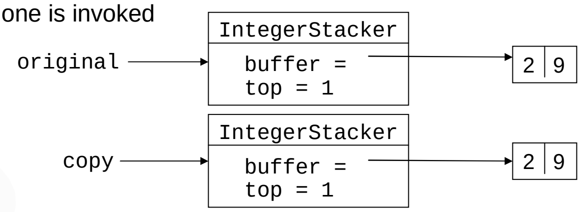
- The `Object` class provides a method named `clone`, which performs a simple clone by copying all fields of the original object to the new object. It works for many classes but may need to be overridden for special purpose.
- Shallow versus deep cloning
  1) Shallow cloning: a simple field by field copy. This might be wrong if it duplicates a reference to an object that shouldn't be shared.

```
public class IntegerStack implements Cloneable {
  private int[] buffer; // a stacker of integers
  private int top;     // largest index in the stacker
                       // (starting from 0)
  . . .
}
```



Object cloning (2)

2) Deep cloning: cloning all of the objects reachable from the object on which clone is invoked



- If you decide that a class needs deep cloning, not the default shallow cloning, then the class must
  1. Implement the `Cloneable` interface
     - `Cloneable` interface has neither methods nor constants, but marks a class as partaking in the cloning mechanism
  2. Redefine the `clone` method with the `public` access modifier
- If you decide that a class just needs shallow cloning, you still need to implement the `Cloneable` interface, redefine `clone` to be `public`, and call `super.clone()`

Interfaces and abstract classes

- Why bother introducing two concepts: abstract class and interface?

```
abstract class Comparable  {
  public abstract int compareTo (Object otherObject);
}
class Employee extends Comparable  {
    pulibc int compareTo(Object otherObject) { . . . }
}
--------------------------------------------------------
public interface Comparable {
    int compareTo (Object otherObject)
}
class Employee implements Comparable  {
    public int compareTo (Object otherObject) { . . . }
}
```

- A class can only extend a single abstract class, but it can implement as many interfaces as it wants
- An abstract class can have a partial implementation, protected parts, static methods and so on, while interfaces are limited to public constants and public methods with no implementation