Interfaces

Computer Science and Engineering ■ College of Engineering ■ The Ohio State University

Lecture 6

Syntax

- An interface is a set of requirements
  - Describes *what* classes should do
  - Does not describe *how* they should do it
- Example

```
public interface Salaried {
  void setSalary(BigDecimal d);
  BigDecimal getSalary();
}
```

- To satisfy this interface, a class must provide *setSalary* and *getSalary* methods with
  - matching signatures (checked by compiler)
  - matching behaviors (up to you)

Good Practice: Use BigDecimal

- Amounts of money (with pennies) should be represented with BigDecimal
  - java.math.BigDecimal
  - Methods for basic arithmetic operations
  - Rounds to given precision
  - Use BigDecimal(String) constructor, avoid BigDecimal(double)
- Double and float are always dangerous, due to rounding errors

```
System.out.println(4.56);  //prints 4.56
System.out.println(4.56*100);
    //prints 455.99999999999994
```

Declaring an Interface

- Looks like a class definition, except:
  - Keyword *interface* replaces class
  - Methods have no body
  - No constructors
- Like a class, an interface can contain
  - Fields
    - Must be ***public static final*** (ie constants)
    - These qualifiers usually omitted (implicit)
  - Methods
    - Must be ***public abstract*** (ie bodiless)
    - These qualifiers usually omitted (implicit)
    - Can not be ***static***
- The interface itself is public or package visible

Examples

```
public interface Salaried {
    void setSalary(BigDecimal d);
    BigDecimal getSalary();
}

interface Voter {
    int MINIMUM_AGE = 18;
    Voter(short age); //compile-time error
    void Register(District d);
    boolean isRegistered();
}
```

Implementing an Interface

- Declare a class that *implements* the interface

```
class Employee implements Salaried {. . .}
```

- Supply definitions for *all* interface methods

```
public void setSalary (BigDecimal d) {
    . . .
}
public BigDecimal getSalary() {
  . . .
}
```

- Note: public modifier of method can *not* be omitted in class definition (even though it is omitted in interface)
- Class can declare more methods than required by interface

Eclipse Demo

- See (interface) Salaried
  - Generate class (boiler plate) from interface
    - New > Class
    - Add interface Salaried
    - Make sure checkbox to create “inherited abstract methods” is selected
- See (class) SafePencil
  - Generate interface from class
    - Refactor > Extract Interface...
    - Select methods to include in interface
  - Problem: concrete representation driving the abstract view

Relationship with Resolve

- Recall Resolve's separation of client-side view and implementer's view
- Client-side
  - Description of *what* a component does
  - Abstract state, the "mathematical model"
  - Requires and ensures clauses
- Implementer's side
  - Description of *how* component works
  - Concrete state, the "representation"
- Matching concepts in Java
  - Interface: Client-side ("abstract instance/template")
  - Class: Implementer ("concrete instance/template")

Role of Interfaces vs Classes

- Interfaces (should) provide
  - Method signatures
  - Mathematical model
  - Constraints (invariants on abstract state)
  - Method specifications
- Classes (should) provide
  - Concrete representation (in private fields)
  - Concrete implementation (in method bodies)
  - Conventions (invariants on concrete representation)
  - Correspondence (abstraction relation mapping concrete representation to abstract state)

```java
//Math Model: salary is a Real
//Constraint (Abs Inv): salary >= 0;
public interface Salaried {

  //Requires: d >= 0;
  //Alters: this.salary
  //Ensures: this.salary = d
  void setSalary(BigDecimal d);

  //Returns: this.salary
  BigDecimal getSalary();
}
```

Good Practice: Naming Interfaces

- How should interfaces be distinguished from classes in their names?
- Resolve approach
  - Classes end in “_1” (or _2, _3,…)
  - eg **`Pencil`** vs **`Pencil_1`**
- Microsoft approach
  - Interfaces start with “I”
  - eg **`IPencil`** vs **`Pencil`**
- Java approach
  - No difference, both are nouns or adjectives
  - eg **`WritingStick`** vs **`Pencil`**

Instantiating an Interface

- The declared type of a variable can be an interface

```
interface Salaried { . . . }
Salaried payee; //ok
```

- But interfaces cannot be instantiated directly

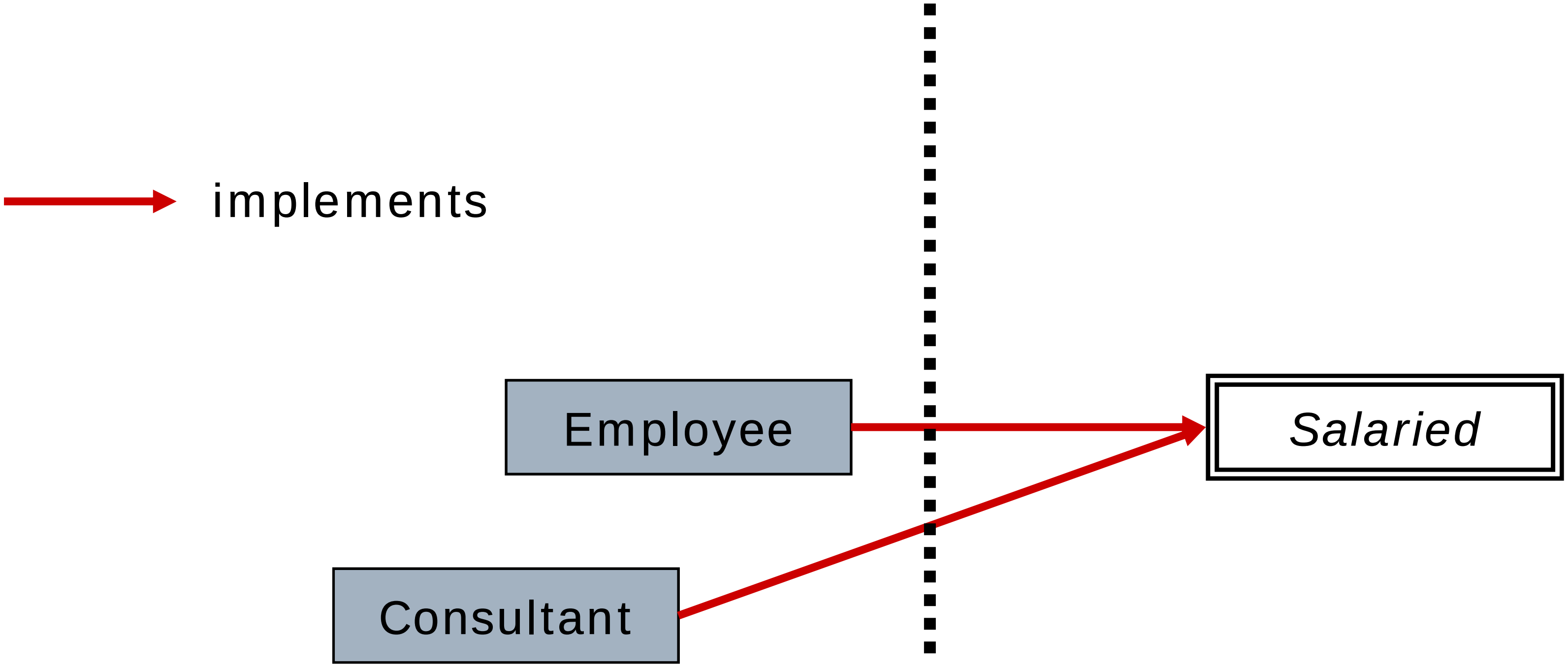
```
payee = new Salaried(); //compile-time error
```

- Only *classes* can be instantiated directly
- Variable of type I can refer to *an instance of a class that implements I*

```
class Employee implements Salaried { . . . }
Salaried payee = new Employee(); //ok
```

- (This might remind you of widening!)

Interfaces and Classes



```
Salaried s = new Employee();
Salaried s2 = new Consultant();
Salaried s3 = s;
```

Declared vs Dynamic Type

- Declared type = set at compile time (by declaration)
- Dynamic type = set at run time (by new)

```
Type1 variable = new Type2();
```

  - Examples

```
Employee p = new Employee(“Pierre”);
Salaried s = new Employee(“Liz”, 12345);
s = p; //dynamic type of s is:
```

- Compiler can not infer dynamic type

```
void select (Salaried s) {
  //declared type of s is: Salaried
  //dynamic type of s is: ???
  . . .
}
```

- Operator *instanceof* tests the run-time type (avoid it!!)

```
if (s instanceof Employee) { ... }
else if (s instanceof Consultant) { ... }
```

Role of Declared Type

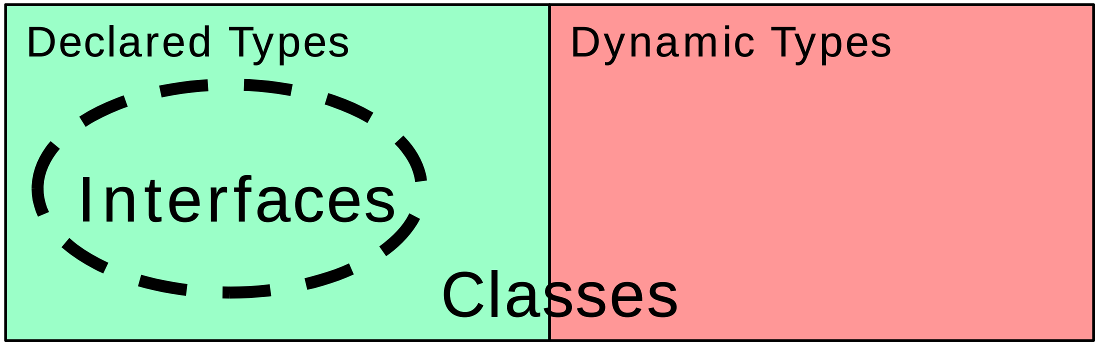
- Declared type determines which members can be used

```
class Employee implements Salaried {
  public void setSalary (BigDecimal d) {...}
  public BigDecimal getSalary() {...}
  public void promote (int r) {...}
}
. . .
void select (Salaried s) {
  s.setSalary(new BigDecimal(“59000.00”));
  s.promote(0);  //compile-time error
}
```

- Only *interface* members can be called/accessed by client
  - Class method is the code to execute when called
  - That method code can access all class members

Simple Rule

- Rule: Interfaces can *only* be used as declared types
  - = Interfaces are never dynamic types
  - = Interfaces are never instantiated
  - = All dynamic types are classes
  - = All run-time objects are constructed from a class, not an interface



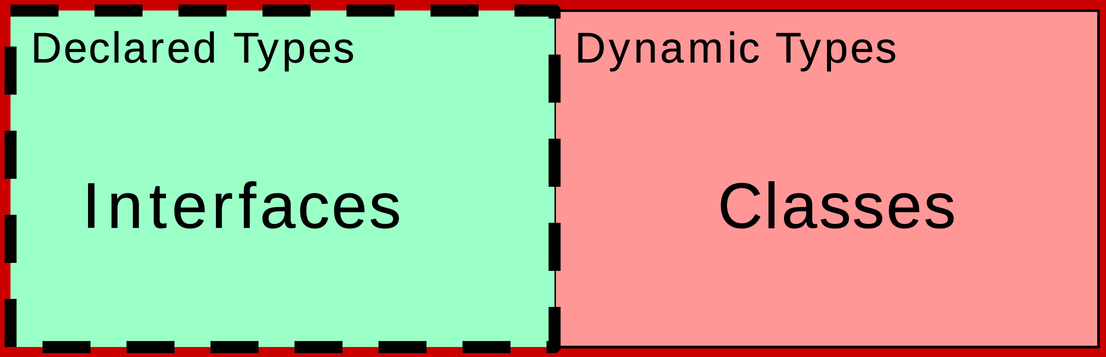
Good Practice: Code to Interface

- "Coding to the interface" means *all* declared types are interface types
  - All variable and field declarations use interface types

    ```
    Salaried lastHire = new Employee();
    ```

  - All argument and return types in method signatures are interface types

    ```
    public Voter choose(Salaried[] s) {...}
    ```



Declared Types

Interfaces

Dynamic Types

Classes

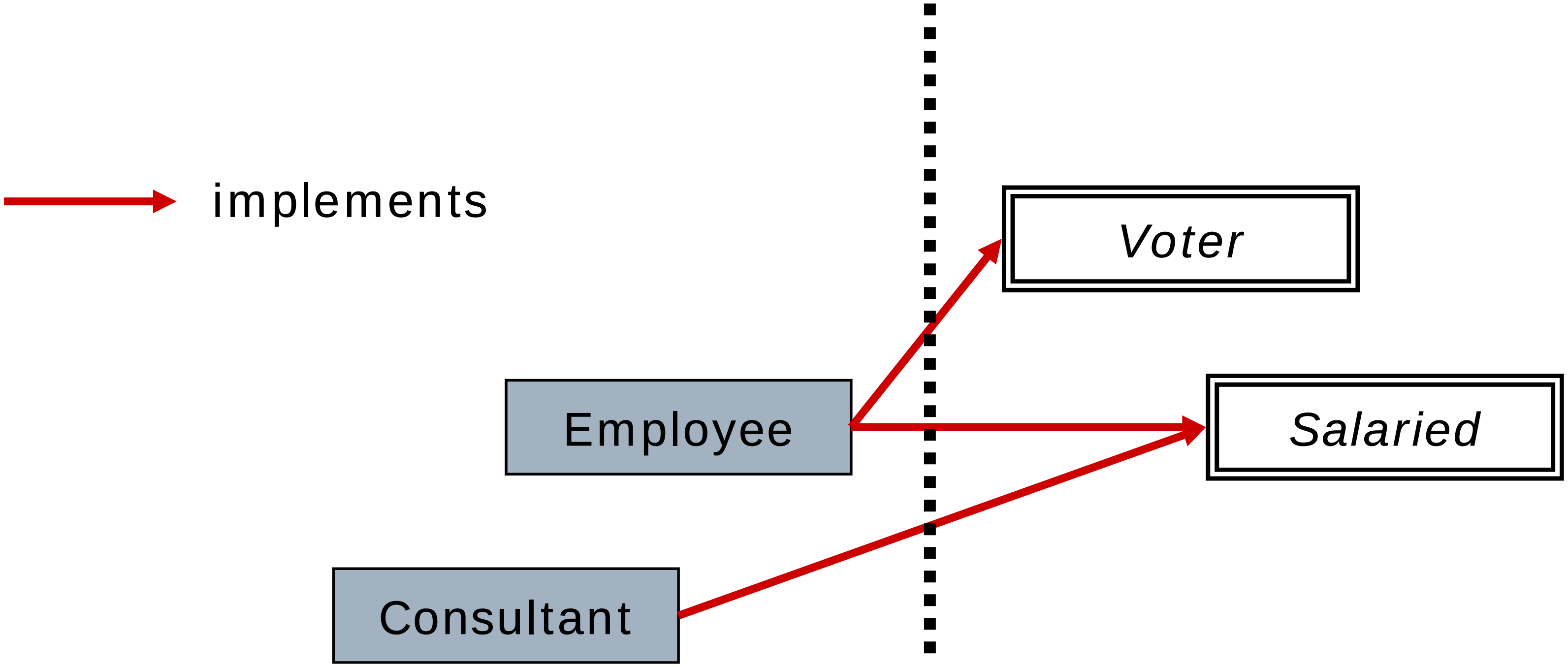
Implementing Multiple Interfaces

- One class can implement several interfaces

  ```
  class Employee implements Salaried,
     Voter {
     . . .
  }
  ```

- Class must provide functionality from *all* interfaces it implements
  - Union of method signatures
  - Satisfies the behavioral contracts of all interfaces it implements

Multiple Interfaces



```
Voter v = new Employee();
Salaried s = new Employee();
Salaried s2 = new Consultant();
Salaried s3 = v; //compile-time error
```

Summary

- Declaring an interface
  - Method signatures without implementation
  - Static final fields (ie constants)
  - All implicitly public
- Implementing an interface
  - Class provides implementation for all methods
- Separation of client-side and implementation
  - Interface has abstract state, invariant, specs
  - Classes have concrete representation, convention
- Declared vs dynamic type
  - Interfaces can not be instantiated