Static and Default Methods in Java 8 Interfaces

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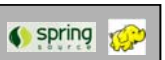
Topics in This Section

- Static methods
- Examples
- Default methods
- Examples
- Resolving conflicts with default methods





Static Methods in Interfaces

Big Idea

- **Static methods in interfaces**
  - Java 7 and earlier
    - No
  - Java 8 and later
    - Yes
  - New rules violate the spirit of interfaces?
    - No (arguably)
- **Concrete (default) methods in interfaces**
  - Java 7 and earlier
    - No
  - Java 8 and later
    - Yes
  - New rules violate the spirit of interfaces?
    - Yes (arguably)

Java 8: Interfaces and Abstract Classes

	Java 7 and Earlier	Java 8 and Later
Abstract Classes	• Can have concrete methods and abstract methods • Can have static methods • Can have instance variables • Class can directly extend one	(Same as Java 7)
Interfaces	• Can only have abstract methods – no concrete methods • Cannot have static methods • Cannot have mutable instance variables • Class can implement any number	• Can have concrete (default) methods and abstract methods • Can have static methods • Cannot have mutable instance variables • Class can implement any number

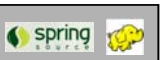
Conclusion: there is little reason to use abstract classes in Java 8. Except for instance variables, Java 8 interfaces can do everything that abstract classes can do, plus are more flexible since classes can implement more than one interface. This means (arguably) that Java 8 has real multiple inheritance.

Static Methods in Interfaces

- **Idea**
  - Java 7 and earlier prohibited static methods in interfaces. Java 8 now allows this
- **Motivation**
  - Seems natural to put operations related to the general type in the interface
  - Does not violate the "spirit" of interfaces
    - `Shape.sumAreas(arrayOfShapes);`
- **Notes**
  - You must use interface name in the method call, even from code within a class that implements the interface
    - Shape.sumAreas, not sumAreas
  - The static methods cannot manipulate static variables
    - Java 8 interfaces continue to prohibit mutable fields





Example: Shape

Example from OOP Section

- **Goal**
  - Want to be able to make mixed collections of Circle, Square, etc.
- **Standard solution**
  - Define Shape interface and have Circle, Square, etc. implement it
- **Goal**
  - Want to be able to sum up the areas of an array of mixed Shapes
- **Standard solution**
  - Put abstract getArea method in the interface, define it in the classes
  - Make static method that takes a Shape[] and sums the areas
- **Java 8 twist**
  - Put static method directly in Shape instead of in a utility class as would have been done in Java 7

Shape

```
public interface Shape {
  double getArea(); // All real shapes must define a getArea

  public static double sumAreas(Shape[] shapes) {
    double sum = 0;
    for(Shape s: shapes) {
      sum = sum + s.getArea();
    }
    return(sum);
  }
}
```

Circle

```
public class Circle implements Shape {
  private double radius;

  public Circle(double radius) {
    this.radius = radius;
  }

  @Override
  public double getArea() {
    return(Math.PI * radius * radius);
  }

  ...
}
```

Rectangle and Square are similar.

ShapeTest

```
public class ShapeTest {
  public static void main(String[] args) {
    Shape[] shapes = { new Circle(10),       // Area is about 314.159
                       new Rectangle(5, 10), // Area is 50
                       new Square(10) };     // Area is 100
    System.out.println("Sum of areas: " +
                       Shape.sumAreas(shapes));
                                          // Area is about 464.159
  }
}
```





Example: Op

Example from First Lambda Section

- **Goal**
  - Want to be able to time various operations without repeating code
- **Java 8 solution**
  - Define functional (1-abstract-method) Op interface
  - Define static method that takes an Op, calls its method, and times it
  - Pass lambdas to the static method

```
TimingUtils.timeOp(() -> someLongOperation(...));
```

- **New twist**
  - Put static method directly in Op instead of in a utility class (TimingUtils)

```
Op.timeOp(() -> someLongOperation(...));
```

Old Approach: The Op Interface

```
@FunctionalInterface
public interface Op {
  void runOp();
}
```


Old Approach: The TimingUtils Class

```
public class TimingUtils {
  private static final double ONE_BILLION =
    1_000_000_000;

  public static void timeOp(Op operation) {
    long startTime = System.nanoTime();
    operation.runOp();
    long endTime = System.nanoTime();
    double elapsedSeconds = (endTime - startTime)/ONE_BILLION;
    System.out.printf("  Elapsed time: %.3f seconds.%n",
                      elapsedSeconds);
  }
}
```

Old Approach: Test Code

```
public class TimingTests {
  public static void main(String[] args) {
    for(int i=3; i<8; i++) {
      int size = (int)Math.pow(10, i);
      System.out.printf("Sorting array of length %,d.%n", size);
      TimingUtils.timeOp(() -> sortArray(size));
    }
  }

  // Supporting methods like sortArray
}
```


Second Approach: The Op Interface

```
@FunctionalInterface
public interface Op {
  static final double ONE_BILLION = 1_000_000_000;

  void runOp();

  static void timeOp(Op operation) {
    long startTime = System.nanoTime();
    operation.runOp();
    long endTime = System.nanoTime();
    double elapsedSeconds = (endTime - startTime)/ONE_BILLION;
    System.out.printf("  Elapsed time: %.3f seconds.%n",
                      elapsedSeconds);
  }
}
```

Second Approach: The TimingUtils Class

- **None!**

Second Approach: Test Code

```
public class TimingTests {
  public static void main(String[] args) {
    for(int i=3; i<8; i++) {
      int size = (int)Math.pow(10, i);
      System.out.printf("Sorting array of length %,d.%n", size);
      Op.timeOp(() -> sortArray(size));
    }
  }

  // Supporting methods like sortArray
}
```

Default Methods in Interfaces

Default (Concrete) Methods in Interfaces

- **Idea**
  - Java 7 and earlier prohibited concrete methods in interfaces. Java 8 now allows this.
- **Motivation**
  - Java needed to add methods like stream and forEach to List.
  - No problem for builtin classes: Java could update the definition of the List interface and all builtin classes that implemented List (ArrayList, etc.)
  - Big problem for custom (user-defined) classes that implemented List: they would fail in Java 8. Would very seriously violate the rule that new Java versions do not break existing code.
- **Note**
  - Some people argue that this breaks the spirit of interfaces, and interfaces are now more like abstract classes. Perhaps (but arguable), but it was a useful trick, and default methods in interfaces are useful in *your* code as well.

Updating the Op Interface

- **Make method to combine two Ops**
  - To produce single Op that runs the code of two other Ops
- **Natural place to put it is in Op itself**

```
Op op1 = () -> someCode(...);
Op op2 = () -> someOtherCode(...);
Op op3 = op1.combinedOp(op2);
Op.timeOp(op3);
```

- **Requires a default method**

```
public interface Op {
  ...
  default Op combinedOp(...) { ... }
}
```


Third Approach: The Op Interface

```
@FunctionalInterface
public interface Op {
  void runOp();

  static void timeOp(Op operation) {
    // Unchanged from last example
  }

  default Op combinedOp(Op secondOp) {
    return(() -> { runOp();
                   secondOp.runOp(); });
  }
}
```

Third Approach: Test Code

```
public static void main(String[] args) {
   for(int i=3; i<8; i++) {
     int size = (int)Math.pow(10, i);
     Op sortArray = () -> sortArray(size);
     Op wasteTime = () -> wasteTime(size);
     Op doBoth = sortArray.combinedOp(wasteTime);
     System.out.printf("Sorting array of length %,d.%n", size);
     Op.timeOp(sortArray);
     System.out.printf("Wasting time (%,d repeats).%n", size);
     Op.timeOp(wasteTime);
     System.out.printf("Doing both (%,d repeats).%n", size);
     Op.timeOp(doBoth);
   }
 }
 // Supporting methods like sortArray and wasteTime
}
```


The Builtin Function Interface

- **Used in section on lambdas part 3**
  - The mapSum method used apply (the main *abstract* method)
  - Code that called mapSum used lambdas or method references
    - `int numEmployees = mapSum(employees, Employee::getSalary);`
- **Used in sections on streams**
  - The builtin map method used apply (the main *abstract* method)
  - Code that called map used lambdas or method references
    - `List<Employee> emps = ids.map(Utils:findEmployee).collect(...);`
- **Used in section on lambdas part 4**
  - Will use the *static* identity method
    - `int sumOfNumbers =  mapSum(listOfIntegers, Function.identity());`
  - Will use the *default* compose & andThen methods
    - `...function1.compose(function2)...`

Source Code for Builtin Function Interface

```
@FunctionalInterface
public interface Function<T, R> {

  R apply(T t);

  default <V> Function<V,R> compose(Function<...> before) {
    ...
  }

  default <V> Function<T, V> andThen(...) { ... }

  static <T> Function<T, T> identity() {
    return t -> t;
  }
}
```


Resolving Conflicts with Default Methods

No Conflicts: Java 7

- **Interfaces Int1 and Int2 specify someMethod**

```
public interface Int1 { int someMethod(); }
public interface Int2 { int someMethod(); }
```

- **Class ParentClass defines someMethod**

```
public class ParentClass {
  public int someMethod() { return(3); }
}
```

- **Examples**

```
public class SomeClass implements Int1, Int2 { ... }
```

  - No conflict: SomeClass must define someMethod, and by doing so, satisfies both interfaces

```
public class ChildClass extends ParentClass implements Int1 { ... }
```

  - No conflict: the child class inherits someMethod from ParentClass, and interface is satisfied

Potential Conflicts: Java 8

- **Interfaces Int1 and Int2 define someMethod**

```
public interface Int1 { default int someMethod() { return(5); } }
public interface Int2 { default int someMethod() { return(7); } }
```

- **Class ParentClass defines someMethod**

```
public class ParentClass {
  public int someMethod() { return(3); }
}
```

- **Examples**

```
public class SomeClass implements Int1, Int2 { ... }
```

  - Potential conflict: whose definition of someMethod wins, the one from Int1 or the one from Int2?

```
public class ChildClass extends ParentClass implements Int1 { ... }
```

  - Potential conflict: whose definition of someMethod wins, the one from ParentClass or the one from Int1?

Resolving Conflicts

- **Classes win over interfaces**

  `public class ChildClass extends ParentClass implements Int1`

  – Conflict resolved: the version of someMethod from ParentClass wins over the version from Int1

  – This rule also means that interfaces cannot provide default implementations for methods from Object (e.g., toString)

    - The methods from the interface could *never* be used, so Java prohibits you from even writing them

- **Conflicting interfaces: you must redefine**

  `public class SomeClass implements Int1, Int2`

  – The conflict cannot be resolved automatically, and SomeClass must give a new definition of someMethod

  – But, this new method can refer to one of the existing methods with Interface1.super.someMethod(…) or Interface2.super.someMethod

Wrap-Up

Summary

- **Static methods**
  - Use for methods that apply *to* instances of that interface
    - Shape.sumAreas(Shape[] shapes)
    - Op.timeOp(Op opToTime)
- **Default methods**
  - Use to add behavior to existing interfaces without breaking classes that already implement the interface
  - Use for operations that are called *on* instances of your interface type
  - Resolving conflicts
    - Classes win over interfaces
    - If two interfaces conflict, class must reimplement the method
      - But the new method can refer to old method by using InterfaceName.super.methodName