

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**

5

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Static Methods in Interfaces

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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)

7

Java 8: Interfaces and Abstract Classes

	Java 7 and Earlier	Java 8 and Later
Abstract Classes	<ul style="list-style-type: none">• 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	<ul style="list-style-type: none">• Can only have abstract methods – no concrete methods• Cannot have static methods• Cannot have mutable instance variables• Class can implement any number	<ul style="list-style-type: none">• 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

9

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Example: Shape

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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

11

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);
    }
}
```

12

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.

13

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
    }
}

```

14

Example: Op

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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();
}
```

17

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);
    }
}
```

18

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
}
```

19

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);
    }
}
```

20

Second Approach: The TimingUtils Class

- **None!**

21

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
}
```

22

Default Methods in Interfaces

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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(...) { ... }  
}
```

25

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(); });  
    }  
}
```

26

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
}
```

27

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)...`

28

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;
    }
}
```

29

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Resolving Conflicts with Default Methods

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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

31

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?

32

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`

33

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Wrap-Up

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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

35

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