

How Pre-defined Non-Concurrent Collectors are Implemented

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Learning Objectives in this Part of the Lesson

- Understand the structure & functionality of non-concurrent collectors for sequential streams
- Know the API for non-concurrent collectors
- Recognize how pre-defined non-concurrent collectors are implemented in the JDK

Class Collectors

```
java.lang.Object  
    java.util.stream.Collectors
```

```
public final class Collectors  
    extends Object
```

Implementations of `Collector` that implement various useful reduction operations, such as accumulating elements into collections, summarizing elements according to various criteria, etc.

The following are examples of using the predefined collectors to perform common mutable reduction tasks:

How Pre-defined Non-Concurrent Collectors are Implemented

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- Collectors is a utility class whose factory methods create collectors for common collection types

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The following are examples of using the predefined collectors to perform common mutable reduction tasks:

See docs.oracle.com/javase/8/docs/api/java/util/stream/Collectors.html

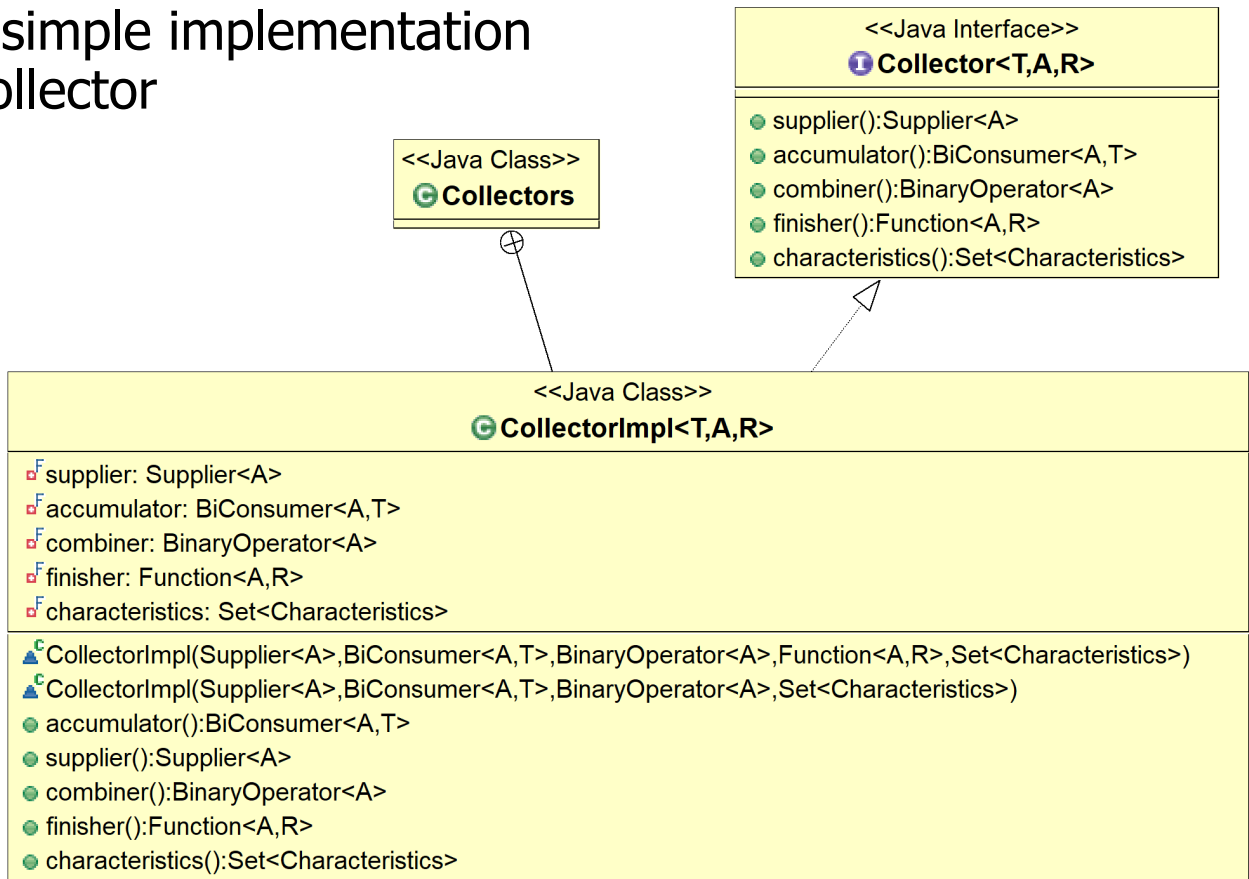
How Pre-defined Non-Concurrent Collectors are Implemented

- Collectors is a utility class whose factory methods create collectors for common collection types
- A utility class is final, has only static methods, no (non-static) state, & a private constructor

```
<<Java Class>>  
Collectors  
  
Collectors()  
toCollection(Supplier<C>):Collector<T,?,C>  
toList():Collector<T,?,List<T>>  
toSet():Collector<T,?,Set<T>>  
joining():Collector<CharSequence,?,String>  
joining(CharSequence):Collector<CharSequence,?,String>  
joining(CharSequence,CharSequence,CharSequence):Collector<CharSequence,?,String>  
mapping(Function<? super T,? extends U>,Collector<? super U,A,R>):Collector<T,?,R>  
collectingAndThen(Collector<T,A,R>,Function<R,RR>):Collector<T,A,RR>  
counting():Collector<T,?,Long>  
minBy(Comparator<? super T>):Collector<T,?,Optional<T>>  
maxBy(Comparator<? super T>):Collector<T,?,Optional<T>>  
summingInt(ToIntFunction<? super T>):Collector<T,?,Integer>  
summingLong(ToLongFunction<? super T>):Collector<T,?,Long>  
summingDouble(ToDoubleFunction<? super T>):Collector<T,?,Double>  
averagingInt(ToIntFunction<? super T>):Collector<T,?,Double>  
averagingLong(ToLongFunction<? super T>):Collector<T,?,Double>  
averagingDouble(ToDoubleFunction<? super T>):Collector<T,?,Double>  
reducing(T,BinaryOperator<T>):Collector<T,?,T>  
reducing(BinaryOperator<T>):Collector<T,?,Optional<T>>  
reducing(U,Function<? super T,? extends U>,BinaryOperator<U>):Collector<T,?,U>  
groupingBy(Function<? super T,? extends K>):Collector<T,?,Map<K,List<T>>>  
toMap(Function<? super T,? extends K>,Function<? super T,? extends U>):Collector<T,?,Map<K,U>>  
summarizingInt(ToIntFunction<? super T>):Collector<T,?,IntSummaryStatistics>  
summarizingLong(ToLongFunction<? super T>):Collector<T,?,LongSummaryStatistics>  
summarizingDouble(ToDoubleFunction<? super T>):Collector<T,?,DoubleSummaryStatistics>
```

How Pre-defined Non-Concurrent Collectors are Implemented

- CollectorImpl defines a simple implementation class used to make a Collector

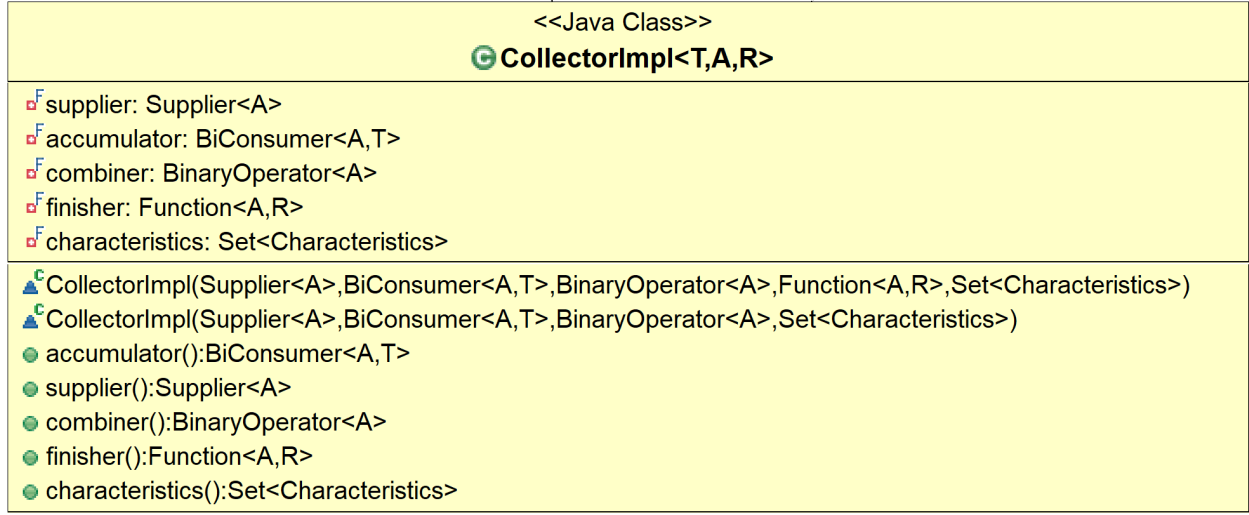
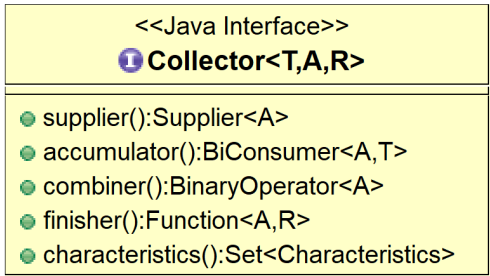
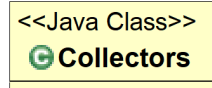


See openjdk/8-b132/java/util/stream/Collectors.java#Collectors.CollectorImpl

How Pre-defined Non-Concurrent Collectors are Implemented

- CollectorImpl defines a simple implementation class used to make a Collector
- However, this class is private to Collectors & is only used internally by the Streams framework

PRIVATE



How Pre-defined Non-Concurrent Collectors are Implemented

- `Collectors.toList()` uses `CollectorImpl` to return a non-concurrent collector that accumulates input elements into a new `(Array)List`

```
final class Collectors {  
    ...  
    public static <T> Collector  
        <T, ?, List<T>>  
        toList() {  
        return new CollectorImpl<>  
            (ArrayList::new,  
            List::add,  
            (left, right) -> {  
                left.addAll(right);  
                return left;  
            },  
            CH_ID);  
        } ...  
}
```


How Pre-defined Non-Concurrent Collectors are Implemented

- Collectors.toList() uses Collector Impl to return a non-concurrent collector that accumulates input elements into a new (Array)List

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            },  
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        } ...  
}
```

The supplier constructor reference

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             (left, right) -> {  
                 left.addAll(right);  
                 return left;  
             },  
             CH_ID);  
        } ...  
}
```

The accumulator method reference

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            (left, right) -> {  
                left.addAll(right);  
                return left;  
            },  
            CH_ID);  
        } ...  
}
```

The combiner lambda expression

This combiner is only used for parallel streams

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final class Collectors {  
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        toList() {  
        return new CollectorImpl<>  
            (ArrayList::new,  
            List::add,  
            (left, right) -> {  
                left.addAll(right);  
                return left;  
            },  
            CH_ID);  
        } ...  
}
```

Characteristics set



CH_ID is defined as Collector.Characteristics.IDENTITY_FINISH

How Pre-defined Non-Concurrent Collectors are Implemented

- `Collectors.toSet()` uses `CollectorImpl` to return a non-concurrent collector that accumulates input elements into a new `(Hash)Set`

```
final class Collectors {  
    ...  
    public static <T> Collector  
        <T, ?, Set<T>>  
        toSet() {  
        return new CollectorImpl<>  
            (HashSet::new,  
            Set::add,  
            (left, right) -> {  
                ...  
            },  
            CH_UNORDERED_ID);  
        } ...  
}
```

How Pre-defined Non-Concurrent Collectors are Implemented

- Collectors.toSet() uses Collector Impl to return a non-concurrent collector that accumulates input elements into a new (Hash)Set

```
final class Collectors {  
    ...  
    public static <T> Collector  
        <T, ?, Set<T>>  
        toSet() {  
        return new CollectorImpl<>  
            (HashSet::new,  
             Set::add,  
             (left, right) -> {  
                 ...  
             },  
             CH_UNORDERED_ID);  
        } ...  
    }
```

The supplier constructor reference

How Pre-defined Non-Concurrent Collectors are Implemented

- `Collectors.toSet()` uses `CollectorImpl` to return a non-concurrent collector that accumulates input elements into a new `(Hash)Set`

```
final class Collectors {  
    ...  
    public static <T> Collector  
        <T, ?, Set<T>>  
        toSet() {  
        return new CollectorImpl<>  
            (HashSet::new,  
             Set::add,  
             (left, right) -> {  
                 ...  
             },  
            CH_UNORDERED_ID);  
        } ...  
}
```

The accumulator method reference

How Pre-defined Non-Concurrent Collectors are Implemented

- Collectors.toSet() uses Collector Impl to return a non-concurrent collector that accumulates input elements into a new (Hash)Set

```
final class Collectors {  
    ...  
    public static <T> Collector  
        <T, ?, Set<T>>  
        toSet() {  
        return new CollectorImpl<>  
            (HashSet::new,  
            Set::add,  
            (left, right) -> {  
                ...  
            },  
            CH_UNORDERED_ID);  
        } ...  
    }
```

```
if (left.size() < right.size())  
    right.addAll(left); return right;  
else  
    left.addAll(right); return left;
```

*The combiner lambda expression
adds the smaller set to the larger set*

This combiner is only used for parallel streams

How Pre-defined Non-Concurrent Collectors are Implemented

- Collectors.toSet() uses Collector Impl to return a non-concurrent collector that accumulates input elements into a new (Hash)Set

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final class Collectors {  
    ...  
    public static <T> Collector  
        <T, ?, Set<T>>  
        toSet() {  
        return new CollectorImpl<>  
            (HashSet::new,  
            Set::add,  
            (left, right) -> {  
                ...  
            },  
            CH_UNORDERED_ID);  
        } ...  
}
```

Characteristics set



CH_UNORDERED_ID is defined as UNORDERED & IDENTITY_FINISH

How Pre-defined Non-Concurrent Collectors are Implemented

- `Collector.of()` defines a simple public factory method that implements a `Collector`

PUBLIC

This of() method is passed four params (last param is optional)

```
interface Collector<T, A, R> { ...
    static<T, R> Collector<T, R, R> of
        (Supplier<R> supplier,
         BiConsumer<R, T> accumulator,
         BinaryOperator<R> combiner,
         Characteristics... chars) {
        ...
        return new Collectors
            .CollectorImpl<>
                (supplier,
                 accumulator,
                 combiner,
                 chars);
        } ...
}
```

How Pre-defined Non-Concurrent Collectors are Implemented

- `Collector.of()` defines a simple public factory method that implements a `Collector`

PUBLIC

This of() method is passed five params (last param is optional)

```
interface Collector<T, A, R> { ...
    static<T, R> Collector<T, R, R> of
        (Supplier<R> supplier,
         BiConsumer<R, T> accumulator,
         BinaryOperator<R> combiner,
         Function<A,R> finisher,
         Characteristics... chars) {
        ...
    return new Collectors
        .CollectorImpl<>
            (supplier,
             accumulator,
             combiner,
             finisher,
             chars); ...
}
```

How Pre-defined Non-Concurrent Collectors are Implemented

- `Collector.of()` defines a simple public factory method that implements a `Collector`
- Both `of()` versions internally use the private `CollectorImpl` class



PRIVATE

```
interface Collector<T, A, R> { ...
    static<T, R> Collector<T, R, R> of
        (Supplier<R> supplier,
         BiConsumer<R, T> accumulator,
         BinaryOperator<R> combiner,
         Function<A,R> finisher,
         Characteristics... chars) {
        ...
    }
    return new Collectors
        .CollectorImpl<>
            (supplier,
             accumulator,
             combiner,
             finisher,
             chars); ...
}
```

See openjdk/8-b132/java/util/stream/Collectors.java#Collectors.CollectorImpl

End of How Pre-defined Non-Concurrent Collectors are Implemented