The Java Streams reduce() Terminal Operation (Part 1)

Douglas C. Schmidt
d.schmidt@vanderbilt.edu
www.dre.vanderbilt.edu/~schmidt

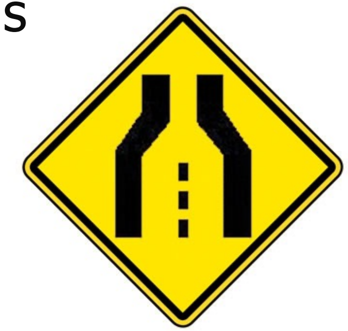
Professor of Computer Science

Institute for Software Integrated Systems

Vanderbilt University
Nashville, Tennessee, USA

Learning Objectives in this Part of the Lesson

- Understand common terminal operations, e.g.
  - forEach()
  - collect()
  - reduce()
    - Know how reduce() performs an immutable reduction
      - Both the two- & three-parameter versions



```
void runCollectReduce() {
  Map<String, Long>
    matchingCharactersMap =
      ...

  long sumOfNameLengths =
    matchingCharactersMap
      .values()
      .stream()
      .reduce(0L,
              Long::sum);
```

We showcase reduce() using the Hamlet program

See github.com/douglascraigschmidt/LiveLessons/tree/master/Java8/ex12

A Stream Terminal Operation That Returns a Primitive

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- The reduce() terminal operation typically returns a primitive value

```
void runCollectReduce1() {
  Map<String, Long>
    matchingCharactersMap =
      ...

  long sumOfNameLengths =
    matchingCharactersMap
      .values()
      .stream()
      .reduce(0L,
              Long::sum);
```

See docs.oracle.com/javase/8/docs/api/java/util/stream/Stream.html#reduce

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```
void runCollectReduce1() {
  Map<String, Long>
    matchingCharactersMap =
      ...
      .collect
        (groupingBy
          (identity(),
           TreeMap::new,
           summingLong
             (String::length)));
```

Create a map associating the names of Hamlet characters with their name lengths.

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```
void runCollectReduce1() {
  Map<String, Long>
    matchingCharactersMap =
      ...

  long sumOfNameLengths =
    matchingCharactersMap
      .values()
      .stream()
      .reduce(0L,
              Long::sum);
```

Convert the map's collection of values into a stream of long values.

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    matchingCharactersMap =
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      .stream()
      .reduce(0L,
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```

Sum up the lengths of all character names in Hamlet.

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```
void runCollectReduce1() {
  Map<String, Long>
    matchingCharactersMap =
      ...

  long sumOfNameLengths =
    matchingCharactersMap
      .values()
      .stream()
      .reduce(0L,
              Long::sum);
```

0 is the "identity," i.e., the initial value of the reduction & the default result if there are no elements in the stream.

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```
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  Map<String, Long>
    matchingCharactersMap =
      ...

  long sumOfNameLengths =
    matchingCharactersMap
      .values()
      .stream()
      .reduce(0L,
              Long::sum);
```

This method reference is an "accumulator," which is a stateless function that combines two values into a single (immutable) "reduced" value.

See docs.oracle.com/javase/8/docs/api/java/lang/Long.html#sum

A Stream Terminal Operation That Returns a Primitive

- The reduce() terminal operation typically returns a primitive value

```
void runCollectReduce1() {
  Map<String, Long>
    matchingCharactersMap =
      ...

  long sumOfNameLengths =
    matchingCharactersMap
      .values()
      .stream()
      .reduce(0L,
              (x, y) -> x + y);
```

A lambda expression could also be used here.

See stackoverflow.com/a/24493905

The Three-Parameter Version of reduce()

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- The three-parameter version of reduce() separates the accumulator from the combiner

```
void runCollectMapReduce() {
  List<String> characterList =
      ...

  long sumOfNameLengths =
    characterList
      .parallelStream()
      .reduce(0L,
              (sum, s) ->
               sum + s.length(),
              Long::sum);
```

Accumulator

Combiner

See docs.oracle.com/javase/8/docs/api/java/util/stream/Stream.html#reduce

The Three-Parameter Version of reduce()

- The three-parameter version of reduce() separates the accumulator from the combiner
  - This variant is primarily used for parallel streams

```
void runCollectMapReduce() {
  List<String> characterList =
      ...

  long sumOfNameLengths =
    characterList
      .parallelStream()
      .reduce(0L,
              (sum, s) ->
               sum + s.length(),
              Long::sum);
```

See www.youtube.com/watch?v=oWlWEKNM5Aw

The Three-Parameter Version of reduce()

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Generate a consistently capitalized & sorted list of names of Hamlet characters starting with the letter 'h'.

```
void runCollectMapReduce() {
  List<String> characterList =
      ...

  long sumOfNameLengths =
    characterList
      .parallelStream()
      .reduce(0L,
              (sum, s) ->
               sum + s.length(),
              Long::sum);
```

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```
void runCollectMapReduce() {
  List<String> characterList =
      ...

  long sumOfNameLengths =
    characterList
      .parallelStream()
      .reduce(0L,
              (sum, s) ->
               sum + s.length(),
              Long::sum);
```

Convert the list into a parallel stream.

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```
void runCollectMapReduce() {
  List<String> characterList =
      ...

  long sumOfNameLengths =
    characterList
      .parallelStream()
      .reduce(0L,
              (sum, s) ->
               sum + s.length(),
             Long::sum);
```

Perform a reduction on the stream with an initial value of 0.

See docs.oracle.com/javase/8/docs/api/java/util/stream/Stream.html#reduce

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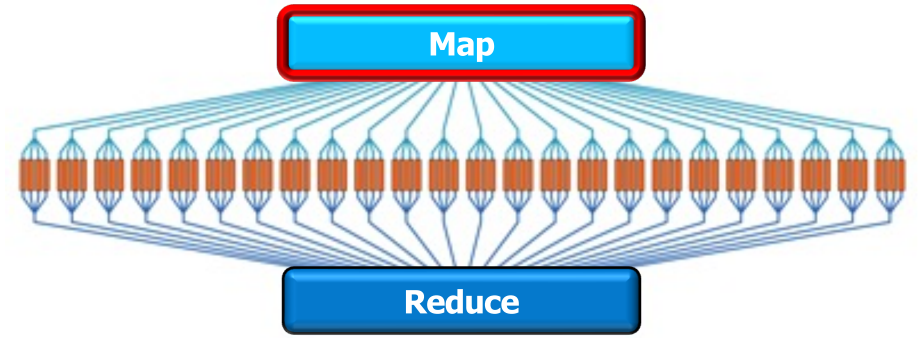

```
void runCollectMapReduce() {
  List<String> characterList =
      ...

  long sumOfNameLengths =
    characterList
      .parallelStream()
      .reduce(0L,
              (sum, s) ->
               sum + s.length(),
              Long::sum);
```

This lambda expression is an accumulator BiFunction that performs the "map" operation in the apply phase.

See docs.oracle.com/javase/8/docs/api/java/util/function/BiFunction.html

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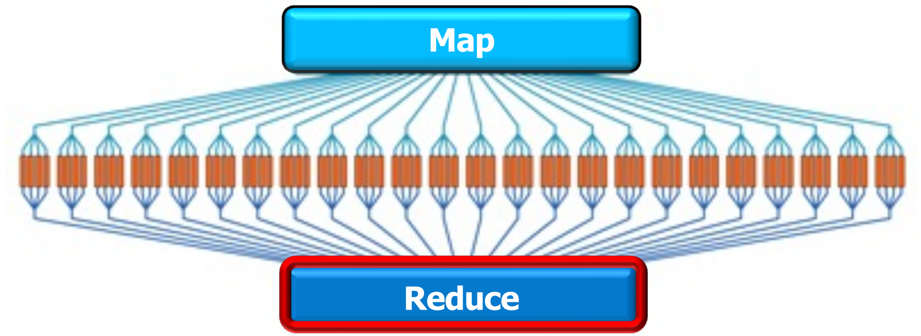

```
void runCollectMapReduce() {
  List<String> characterList =
      ...

  long sumOfNameLengths =
    characterList
      .parallelStream()
      .reduce(0L,
              (sum, s) ->
               sum + s.length(),
              Long::sum);
```

This method reference is a combiner BinaryOperator that performs the "reduce" operation in the combine phase.

See docs.oracle.com/javase/8/docs/api/java/lang/Long.html#sum

The Three-Parameter Version of reduce()

- The three-parameter version of reduce() separates the accumulator from the combiner
  - This variant is primarily used for parallel streams
  - It can also be used when the type being streamed is different from the type of the accumulator

```
void runCollectMapReduceEx() {
  Map<String, Double> base =
    new HashMap<>() { ... }
  Map<String, Double> actual =
    new HashMap<>() { ...  }

  Double percentageChange = base
  .entrySet()
  .parallelStream()
  .reduce(0.0,
          (sum, entry) -> {
             ...
             return sum + ...;
          },
          Double::sum);
```

'sum' is a Double & 'entry' is a Map.Entry<>

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End of the Java Streams reduce() Terminal Operation (Part 1)