Learn How Java Parallel Streams Work "Under the Hood"

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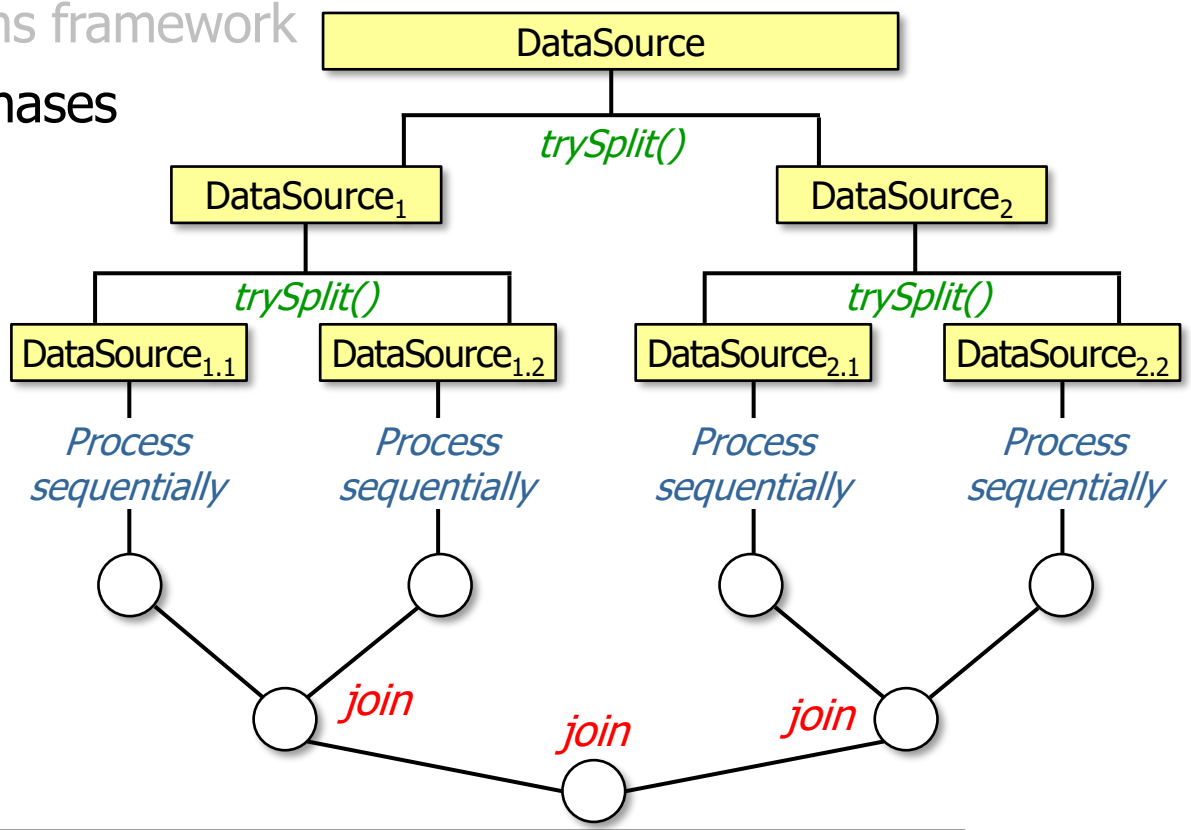
Learning Objectives in this Part of the Lesson

- Know how aggregate operations & functional programming features are applied in the parallel streams framework
- Learn how parallel stream phases work "under the hood"



See developer.ibm.com/articles/j-java-streams-3-brian-goetz

Overview of How a Parallel Stream Works

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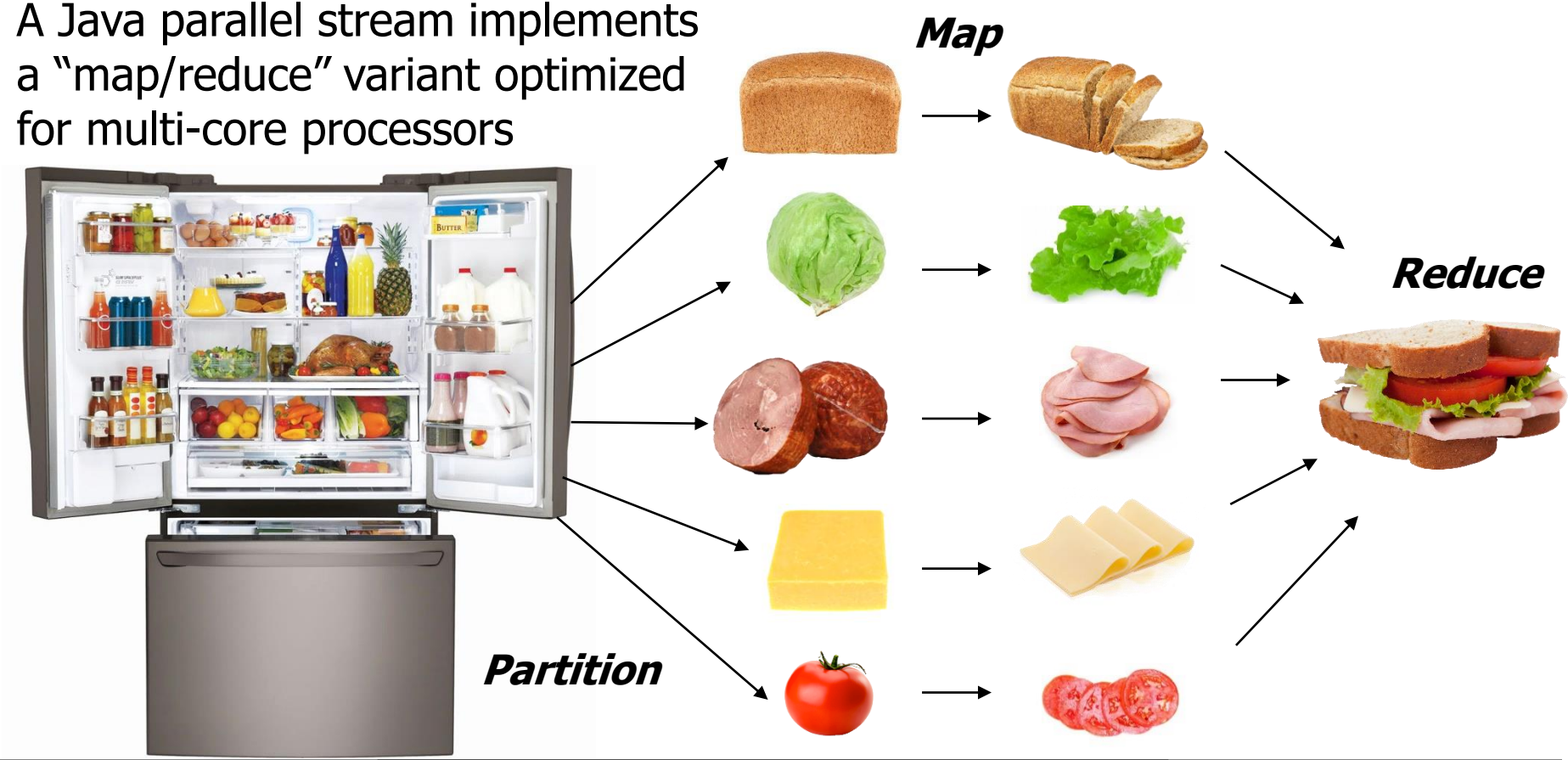
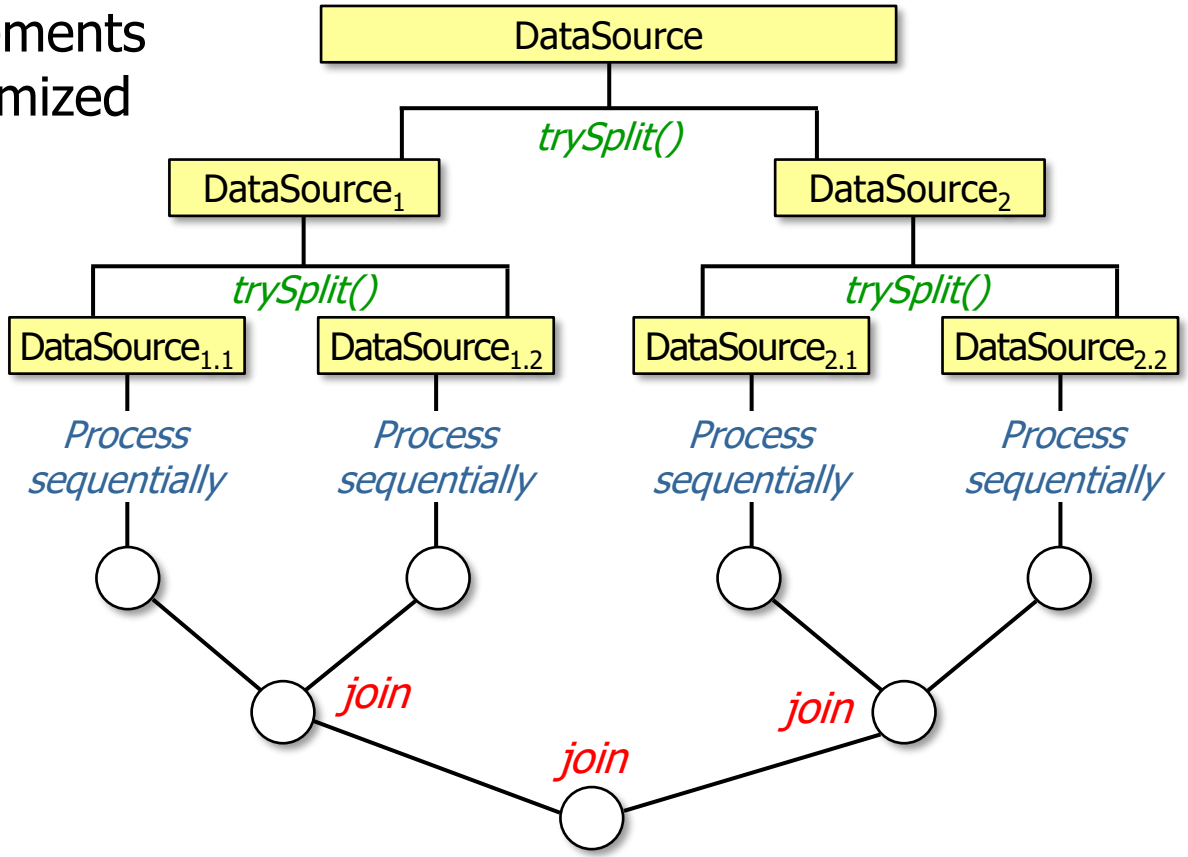
- A Java parallel stream implements a "map/reduce" variant optimized for multi-core processors



See en.wikipedia.org/wiki/MapReduce

Overview of How a Parallel Stream Works

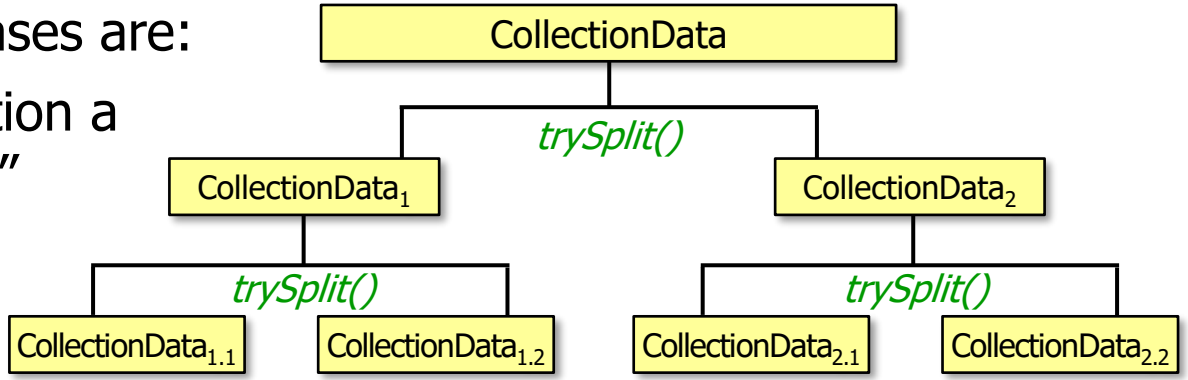
- A Java parallel stream implements a "map/reduce" variant optimized for multi-core processors
  - It's actually a three phase "split-apply-combine" data processing strategy



See www.jstatsoft.org/article/view/v040i01

Overview of How a Parallel Stream Works

- The split-apply-combine phases are:
  1. **Split** – Recursively partition a data source into "chunks"



See en.wikipedia.org/wiki/Divide_and_conquer_algorithm

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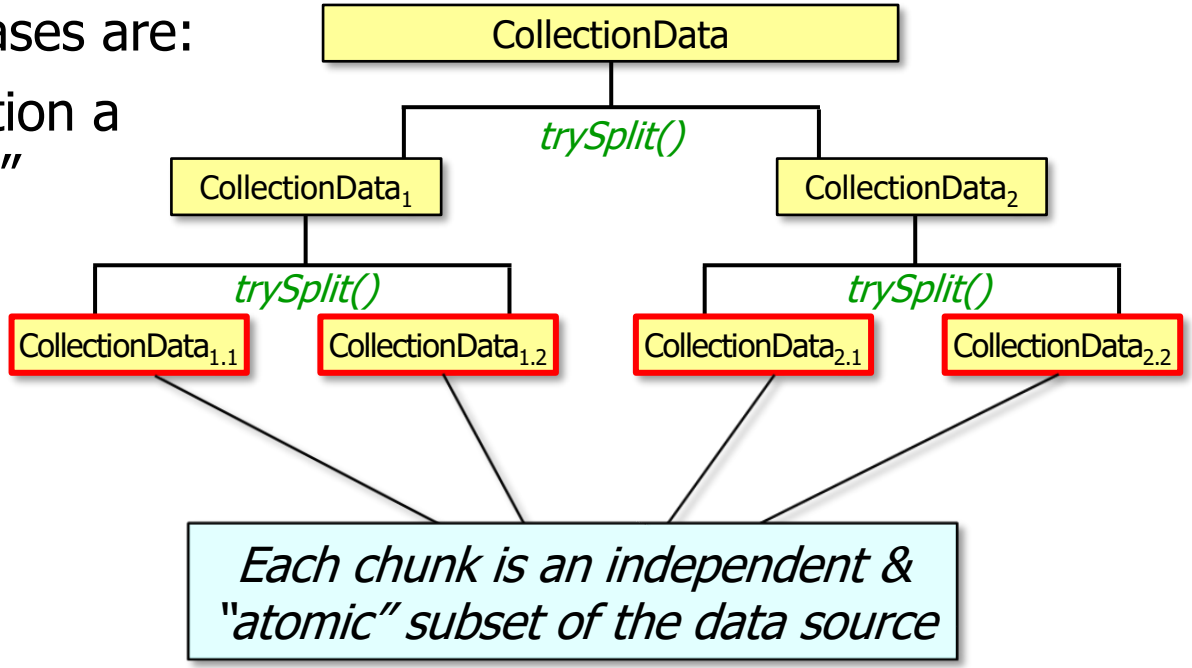
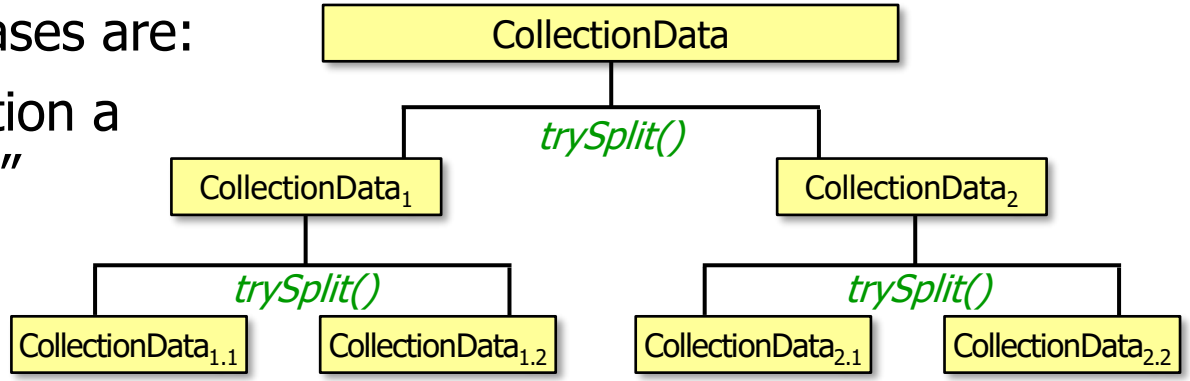


See upcoming lesson on "*Java Parallel Stream Internals: Partitioning*"

Overview of How a Parallel Stream Works

- The split-apply-combine phases are:
  1. **Split** – Recursively partition a data source into "chunks"
     - Spliterators partition collections in Java




```
public interface Spliterator<T> {
  boolean tryAdvance(Consumer<? Super T> action);

  Spliterator<T> trySplit();

  long estimateSize();

  int characteristics();
}
```

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

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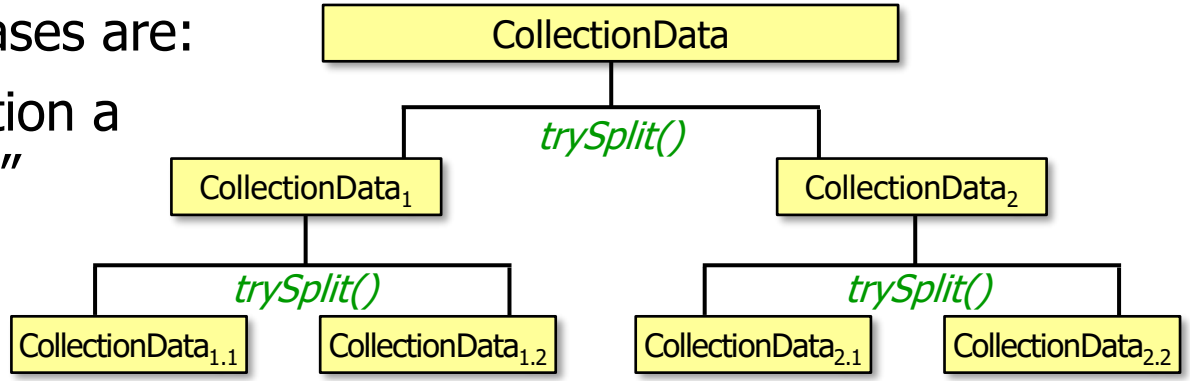

Used for sequential (& parallel) streams

```
public interface Spliterator<T> {
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See docs.oracle.com/javase/8/docs/api/java/util/Spliterator.html#tryAdvance

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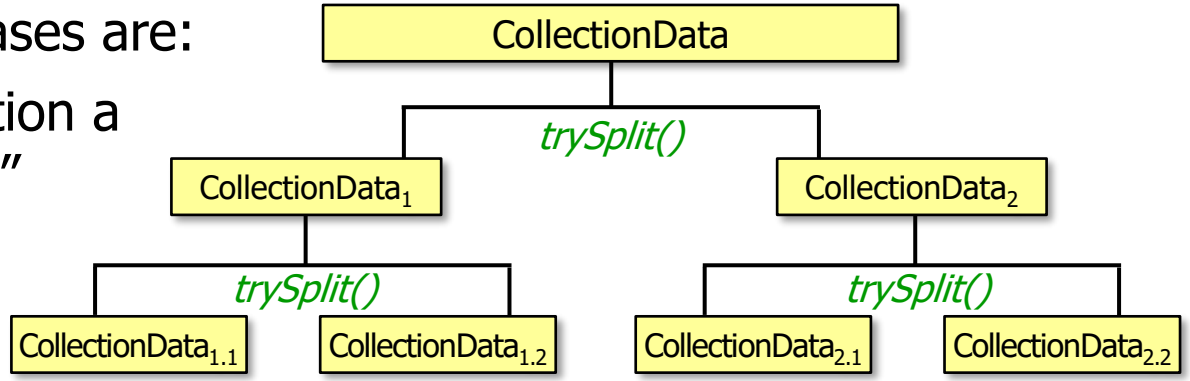


Used only for parallel streams

```
public interface Spliterator<T> {
  boolean tryAdvance(Consumer<? Super T> action);

  Spliterator<T> trySplit();

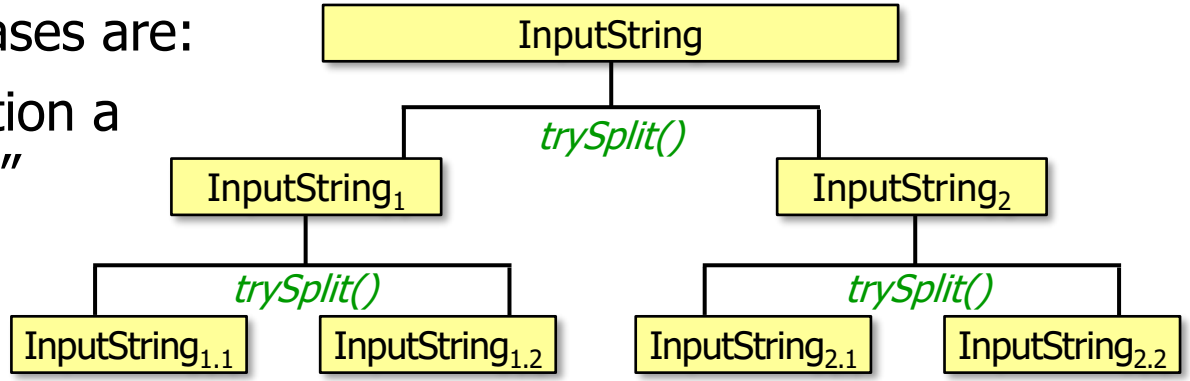
  long estimateSize();

  int characteristics();
}
```

See docs.oracle.com/javase/8/docs/api/java/util/Spliterator.html#trySplit

Overview of How a Parallel Stream Works

- The split-apply-combine phases are:
  1. **Split** – Recursively partition a data source into "chunks"
     - Spliterators partition collections in Java
     - Each Java collection has a spliterator



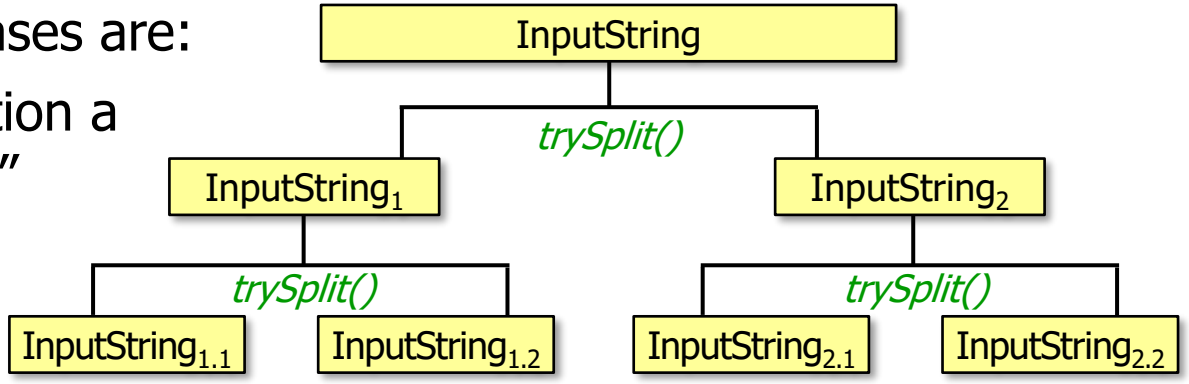

```
interface Collection<E> {
  ...
  default Spliterator<E> spliterator() {
    return Spliterators.spliterator(this, 0);
  }

  default Stream<E> parallelStream() {
    return StreamSupport.stream(spliterator(), true);
  }
 ...
}
```

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

Overview of How a Parallel Stream Works

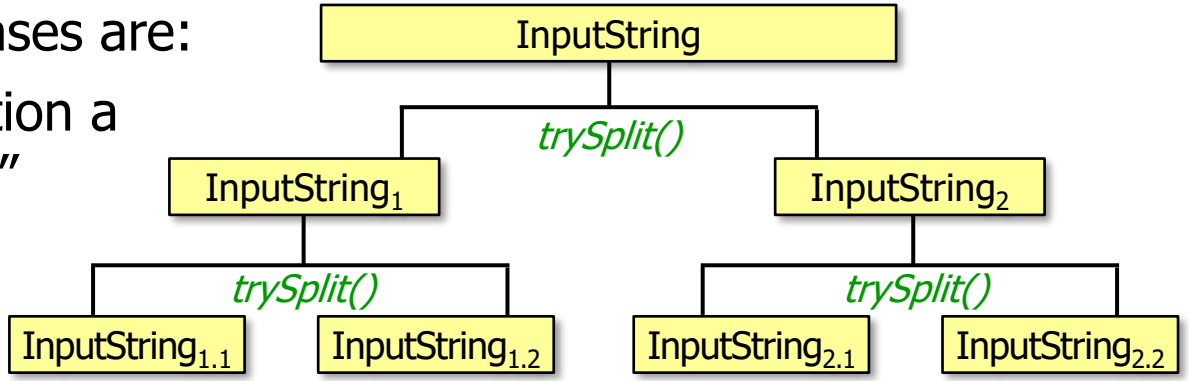
- The split-apply-combine phases are:
  1. **Split** – Recursively partition a data source into "chunks"
     - Spliterators partition collections in Java
     - Each Java collection has a spliterator
     - Programmers can define custom spliterators



See github.com/douglascraigschmidt/LiveLessons/tree/master/SearchStreamSpliterator

Overview of How a Parallel Stream Works

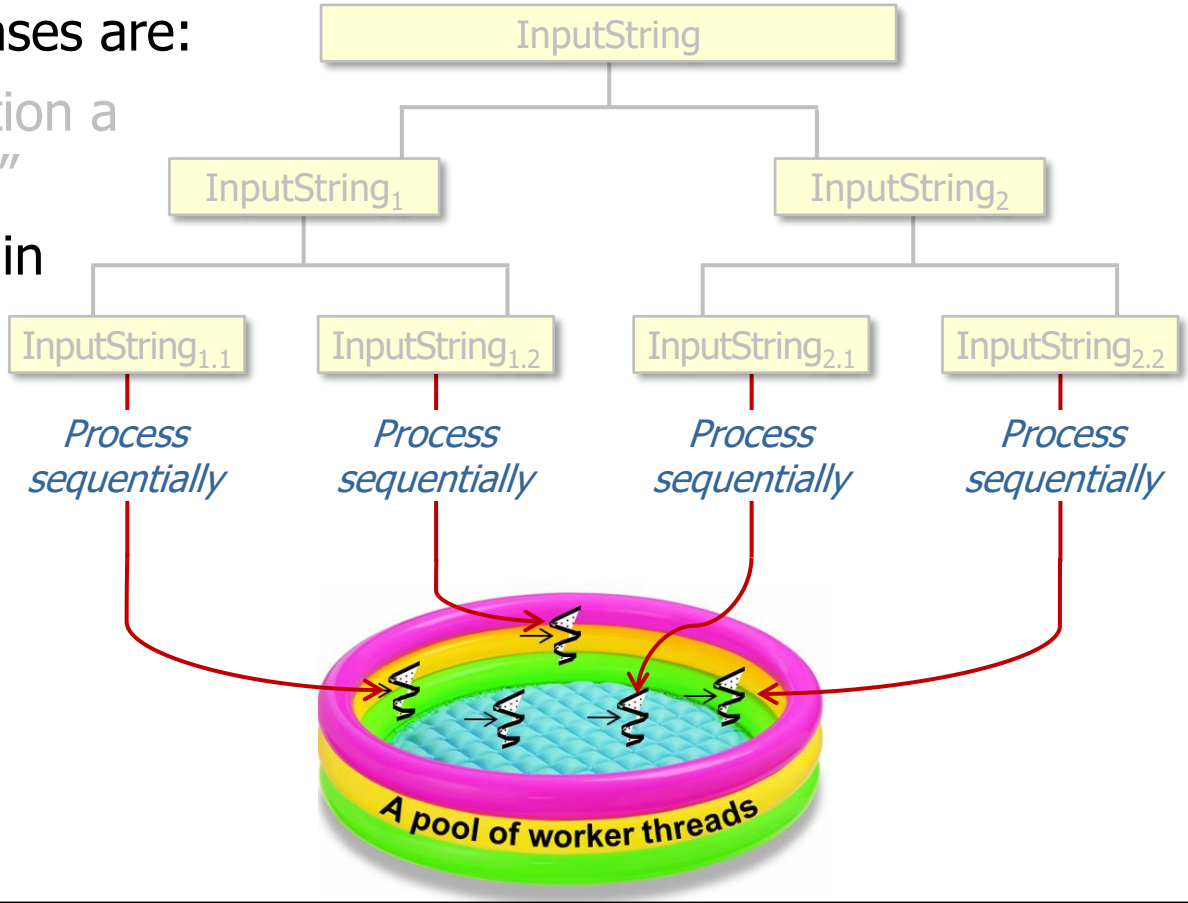
- The split-apply-combine phases are:
  1. **Split** – Recursively partition a data source into "chunks"
     - Spliterators partition collections in Java
     - Each Java collection has a spliterator
     - Programmers can define custom spliterators
     - Parallel streams perform better on data sources that can be split efficiently & evenly



See www.airpair.com/java/posts/parallel-processing-of-io-based-data-with-java-streams

Overview of How a Parallel Stream Works

- The split-apply-combine phases are:
  1. **Split** – Recursively partition a data source into "chunks"
  2. **Apply** – Process chunks in a common thread pool



See lesson on "*Java Parallel Stream Internals: Parallel Processing via the Common ForkJoinPool*"

Overview of How a Parallel Stream Works

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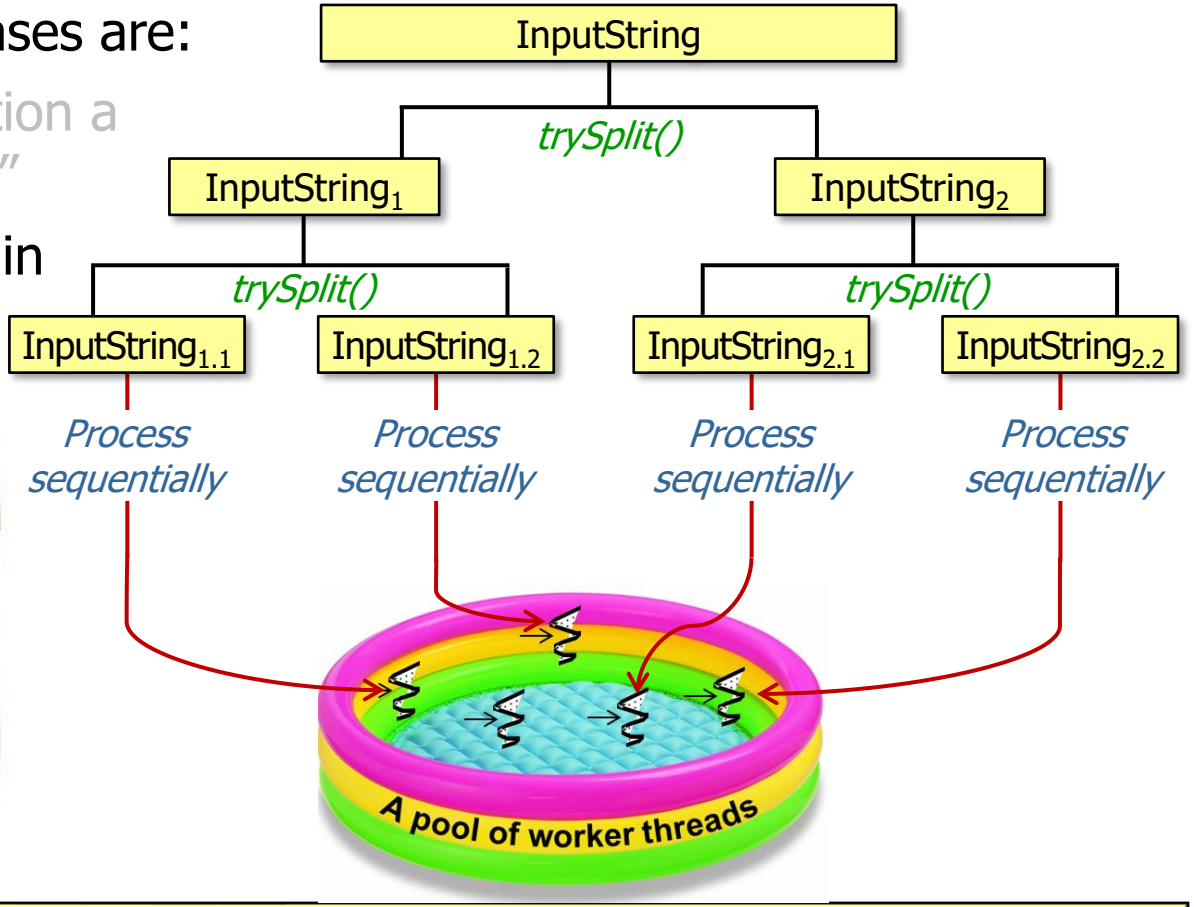
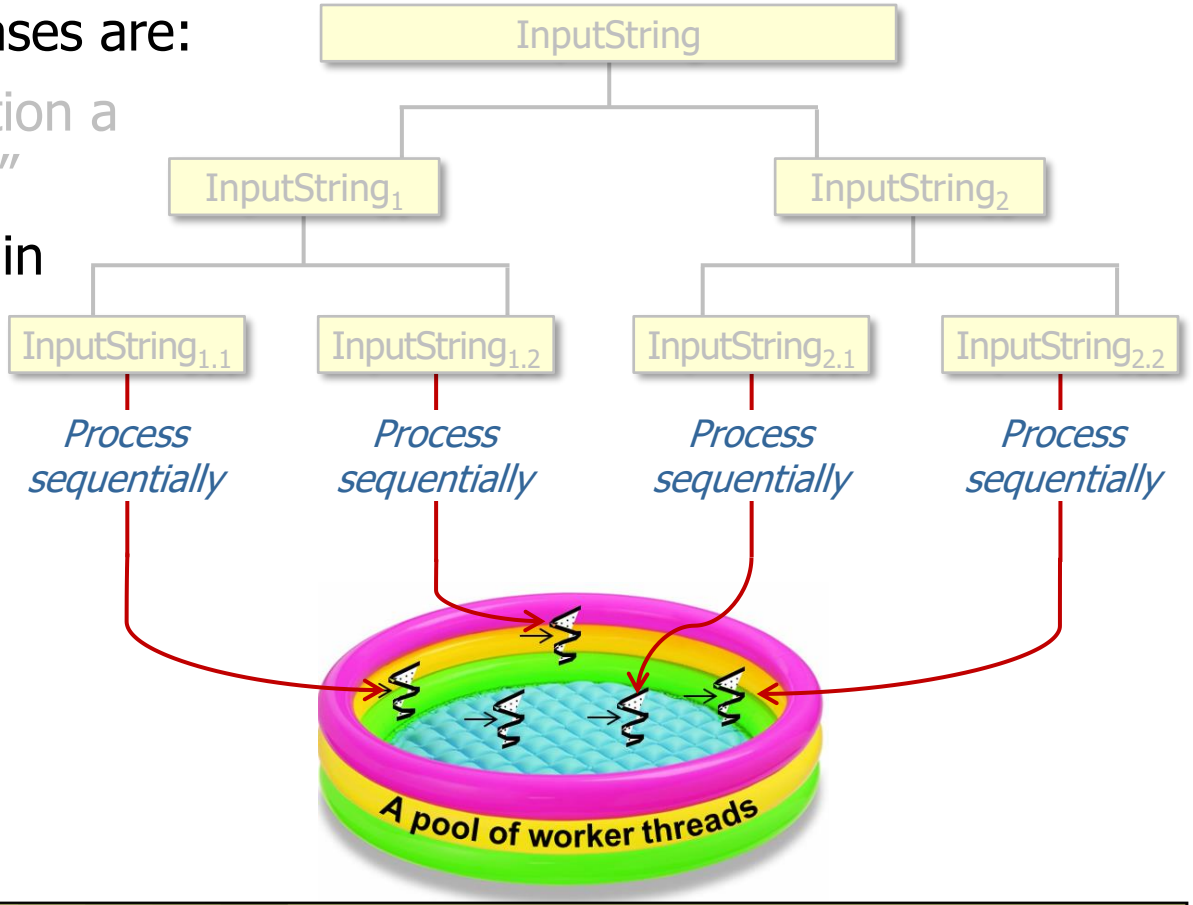


Splitting & applying run simultaneously (after certain limits met), not sequentially

Overview of How a Parallel Stream Works

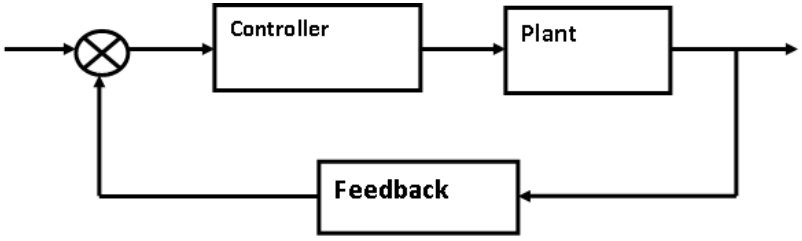
- The split-apply-combine phases are:
  1. **Split** – Recursively partition a data source into "chunks"
  2. **Apply** – Process chunks in a common thread pool
     - Utilization's maximized via "work-stealing"

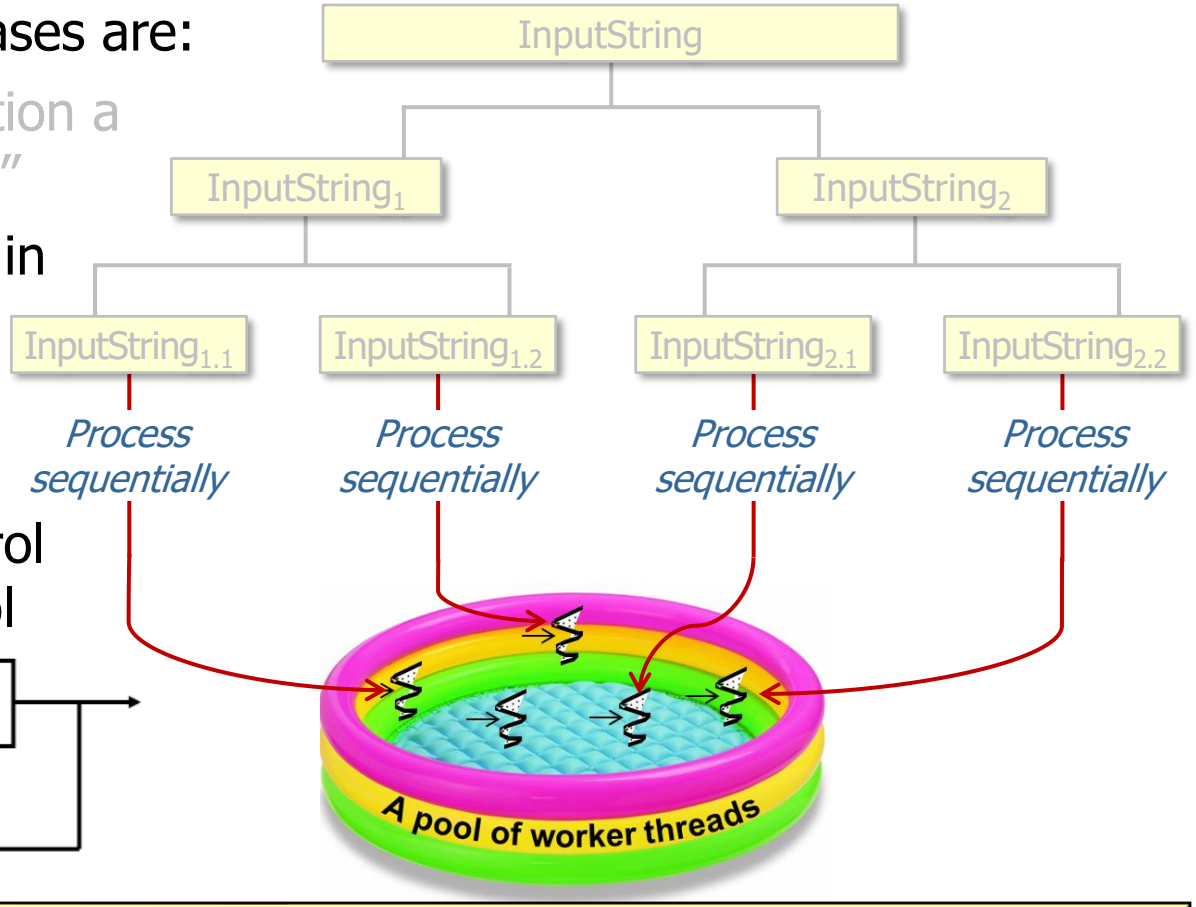


See lesson on "*Java Parallel Stream Internals: Mapping onto the Common ForkJoinPool*"

Overview of How a Parallel Stream Works

- The split-apply-combine phases are:
  1. **Split** – Recursively partition a data source into "chunks"
  2. **Apply** – Process chunks in a common thread pool
     - Utilization's maximized via "work-stealing"
     - Programmers can control # of threads in the pool

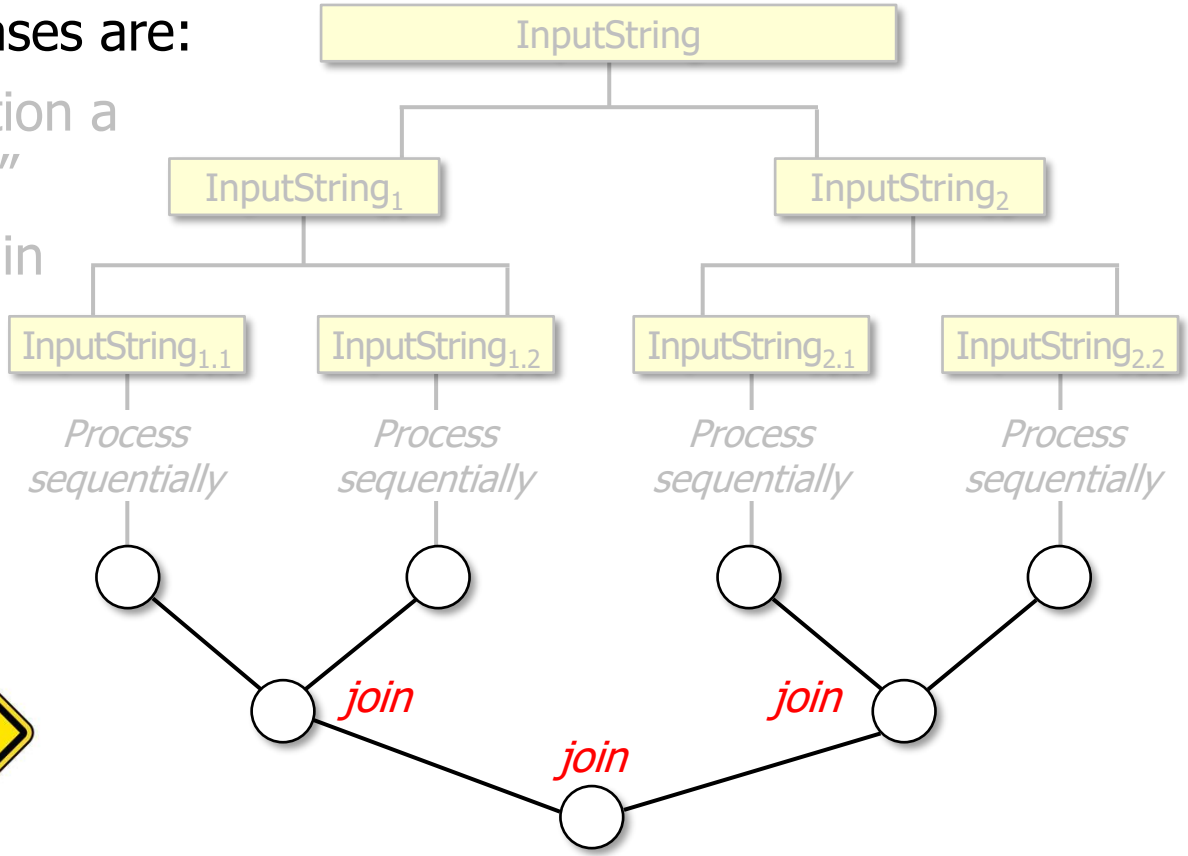




See lesson on "*Java Parallel Stream Internals: Configuring the Common Fork-Join Pool*"

Overview of How a Parallel Stream Works

- The split-apply-combine phases are:
  1. **Split** – Recursively partition a data source into "chunks"
  2. **Apply** – Process chunks in a common thread pool
  3. **Combine** – Join partial results to a single result



See upcoming lessons on "*Java Parallel Stream Internals: Combining Results*"

Overview of How a Parallel Stream Works

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  1. **Split** – Recursively partition a data source into "chunks"
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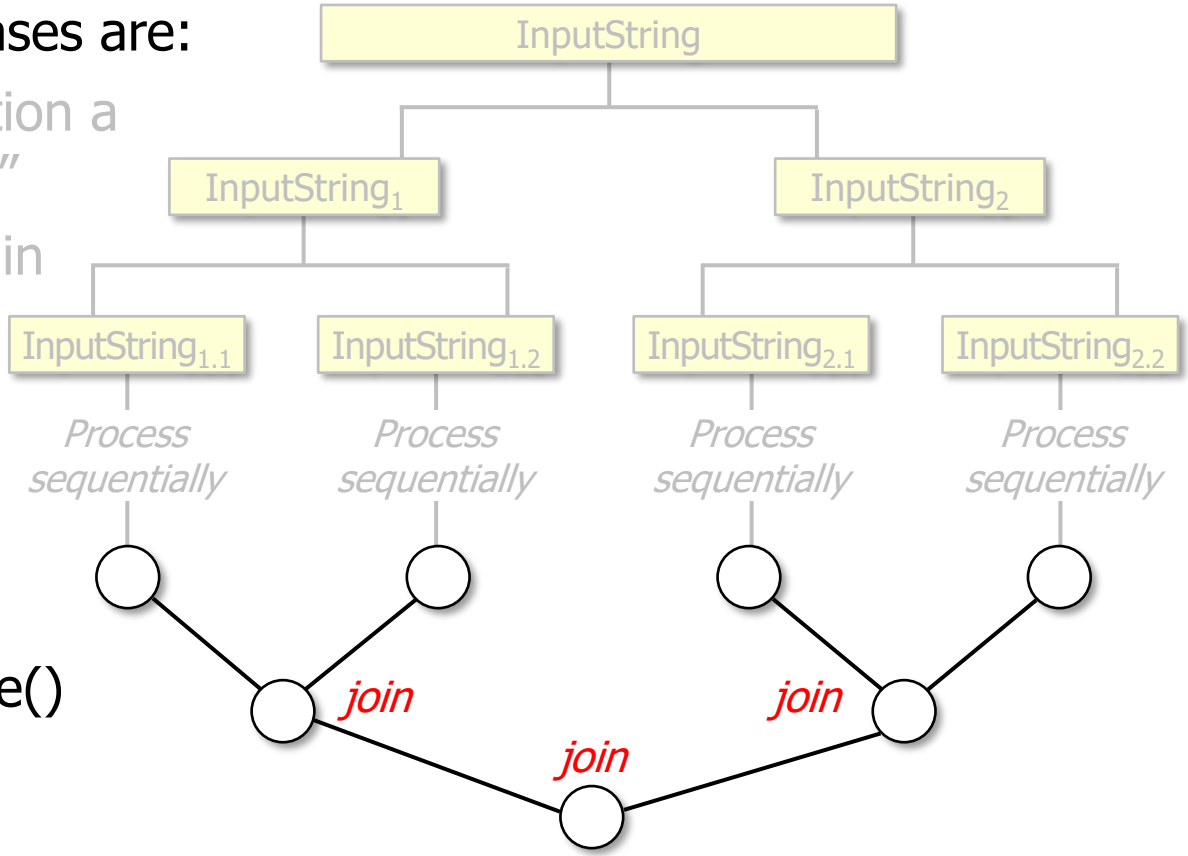
  3. **Combine** – Join partial results to a single result
     - Performed by terminal operations
       - e.g., collect() & reduce()



See www.codejava.net/java-core/collections/java-8-stream-terminal-operations-examples

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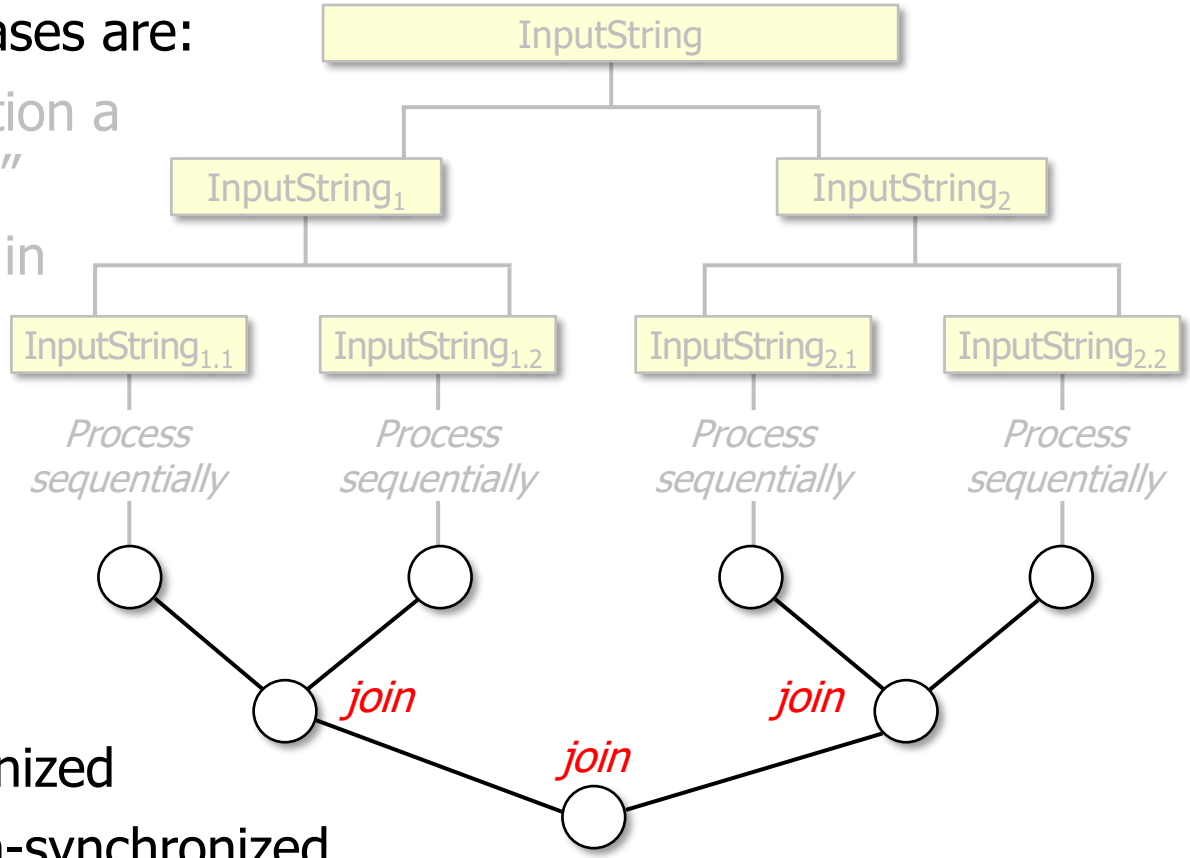
     - Performed by terminal operations
     - Collectors can either be
       - Concurrent – synchronized
       - Non-concurrent – non-synchronized



See lessons on "*Java Parallel Stream Internals: Non-Concurrent & Concurrent Collectors*"

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Programmers can define custom collectors

End of Learn How Java Parallel Streams Work "Under the Hood"