Overview of Java Parallel Streams: Transitioning to Parallelism

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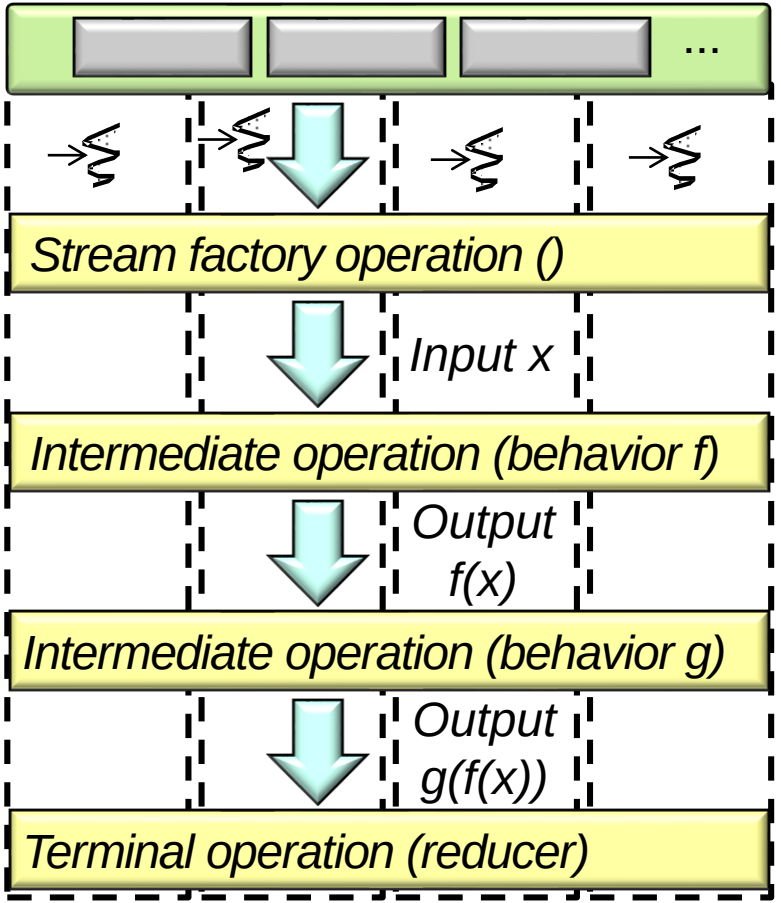
Learning Objectives in this Part of the Lesson

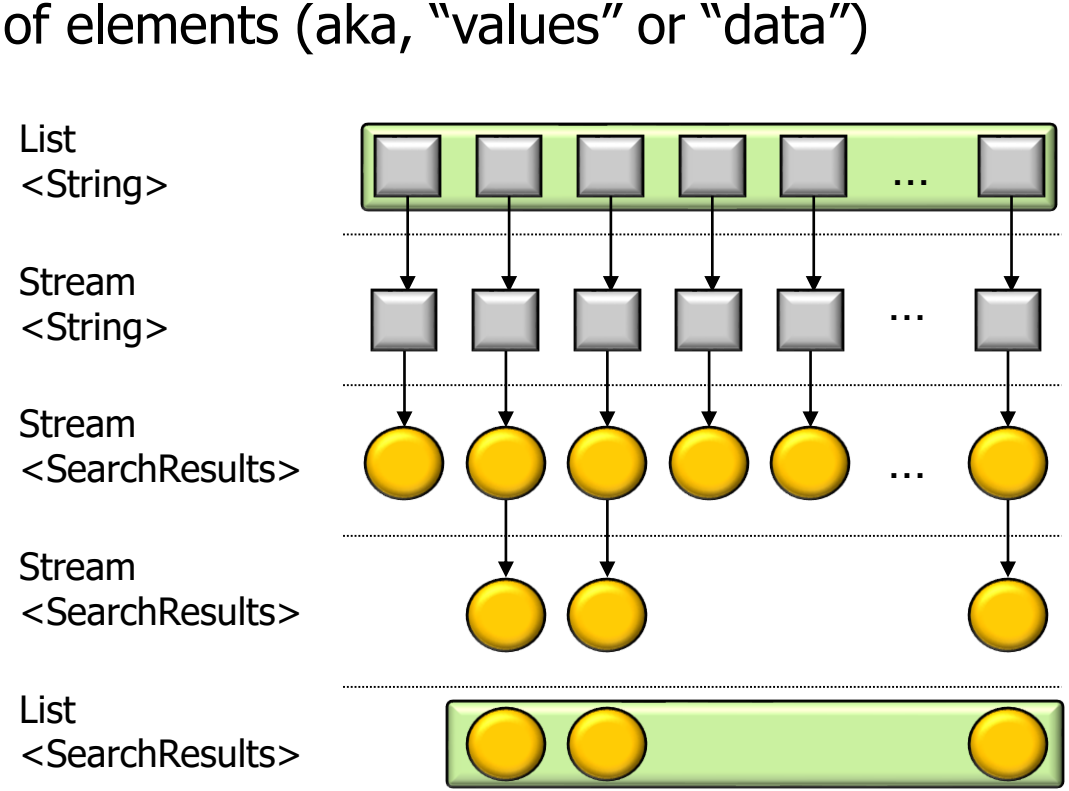
- Know how aggregate operations from Java sequential streams are applied in the parallel streams framework

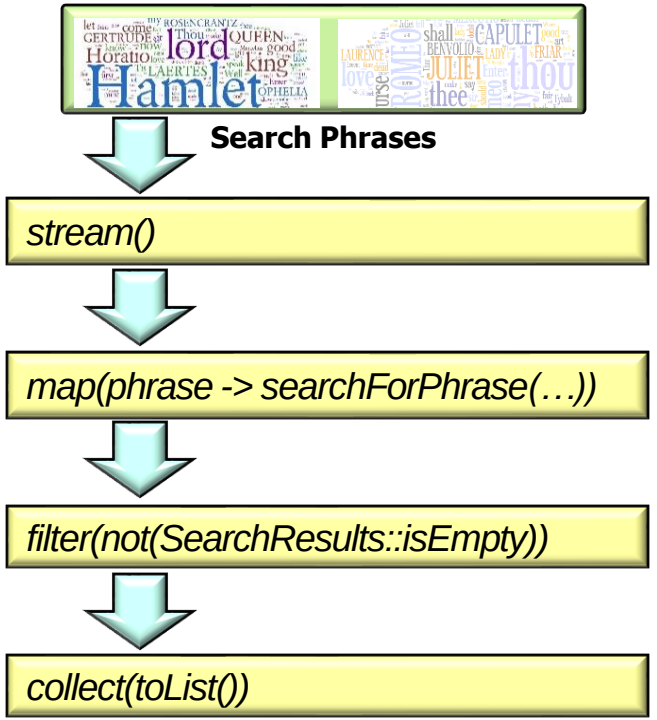


Transitioning from Sequential Streams to Parallel Streams

Transitioning from Sequential Streams to Parallel Streams

- A Java stream is a pipeline of aggregate operations that process a sequence of elements (aka, "values" or "data")





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

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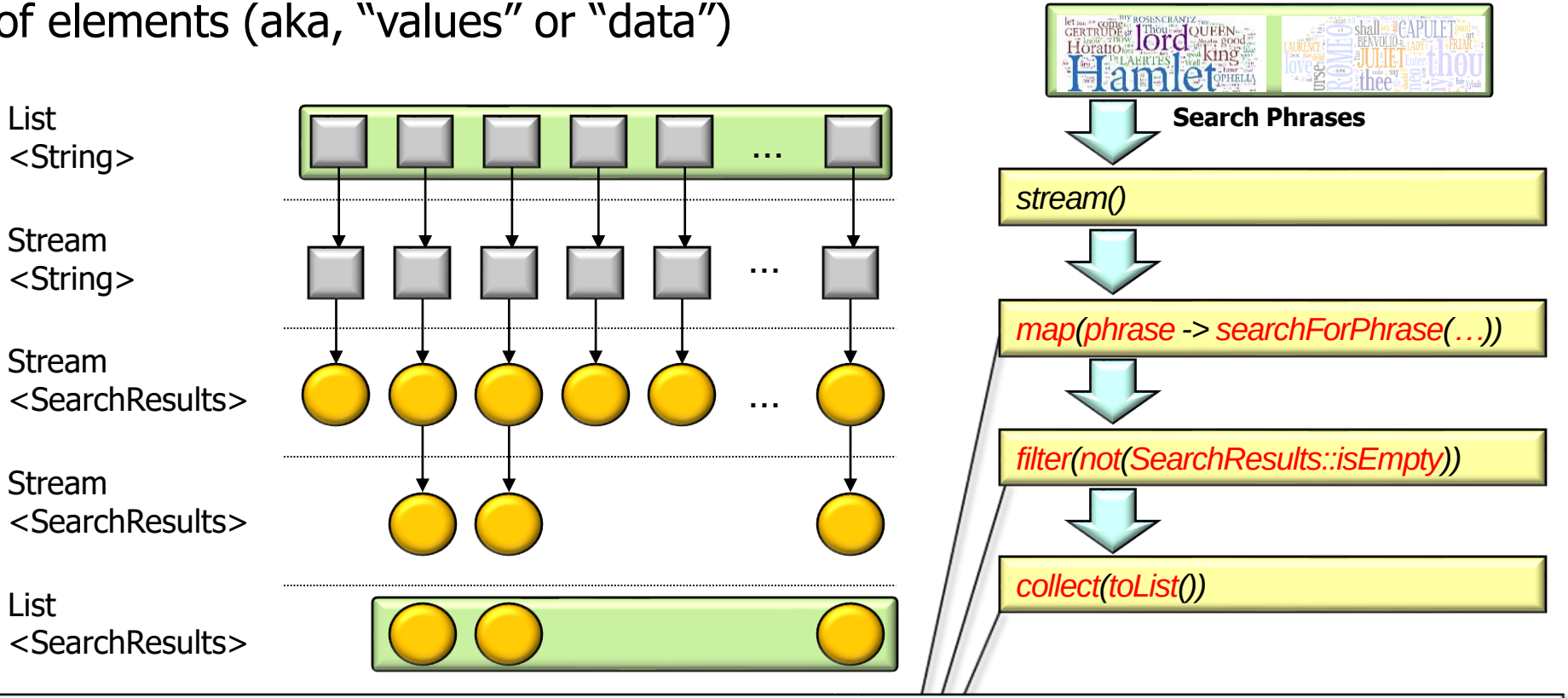
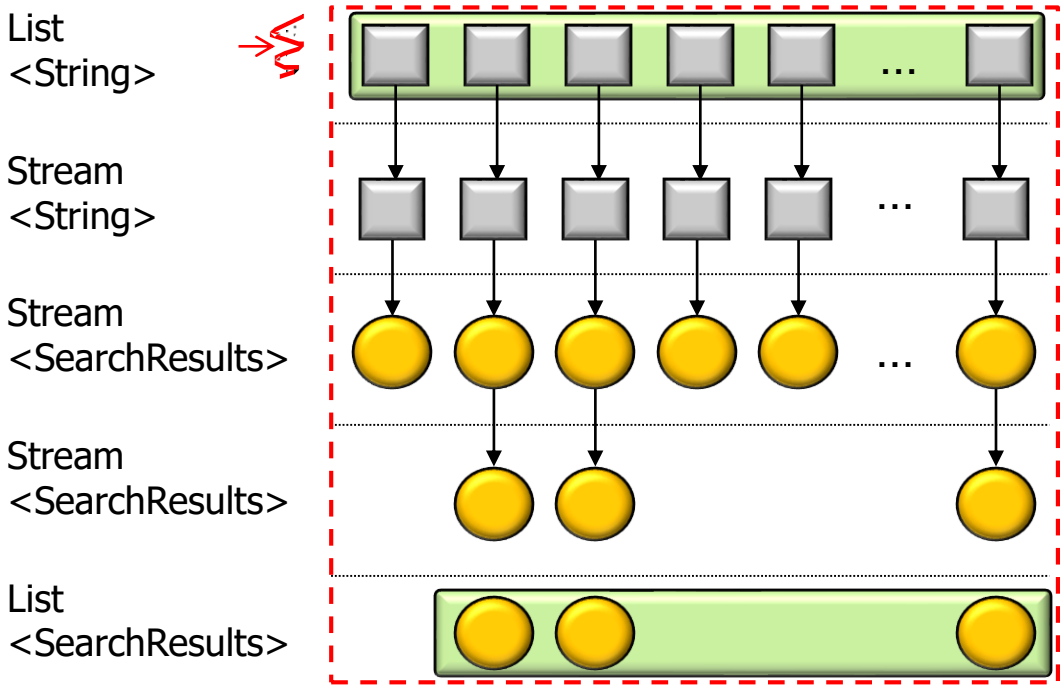
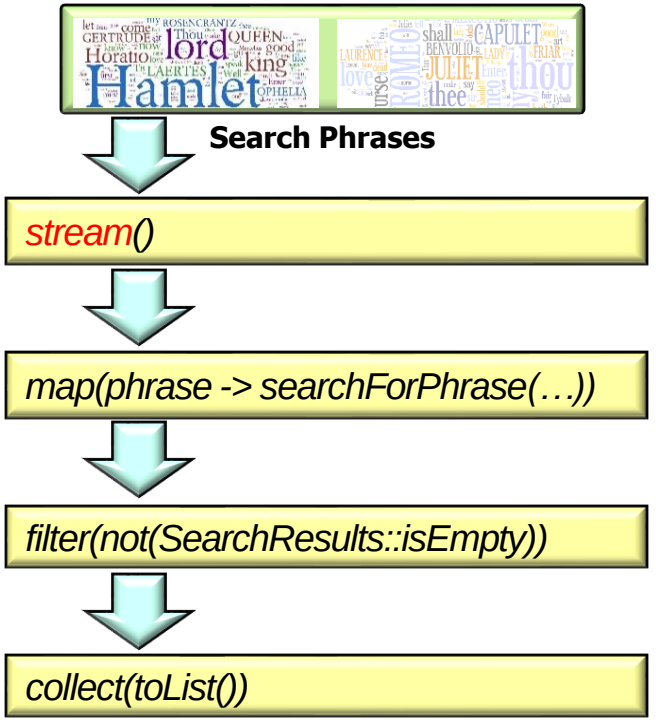


Aggregate operations use internal iteration & behaviors to process elements in a stream

Transitioning from Sequential Streams to Parallel Streams

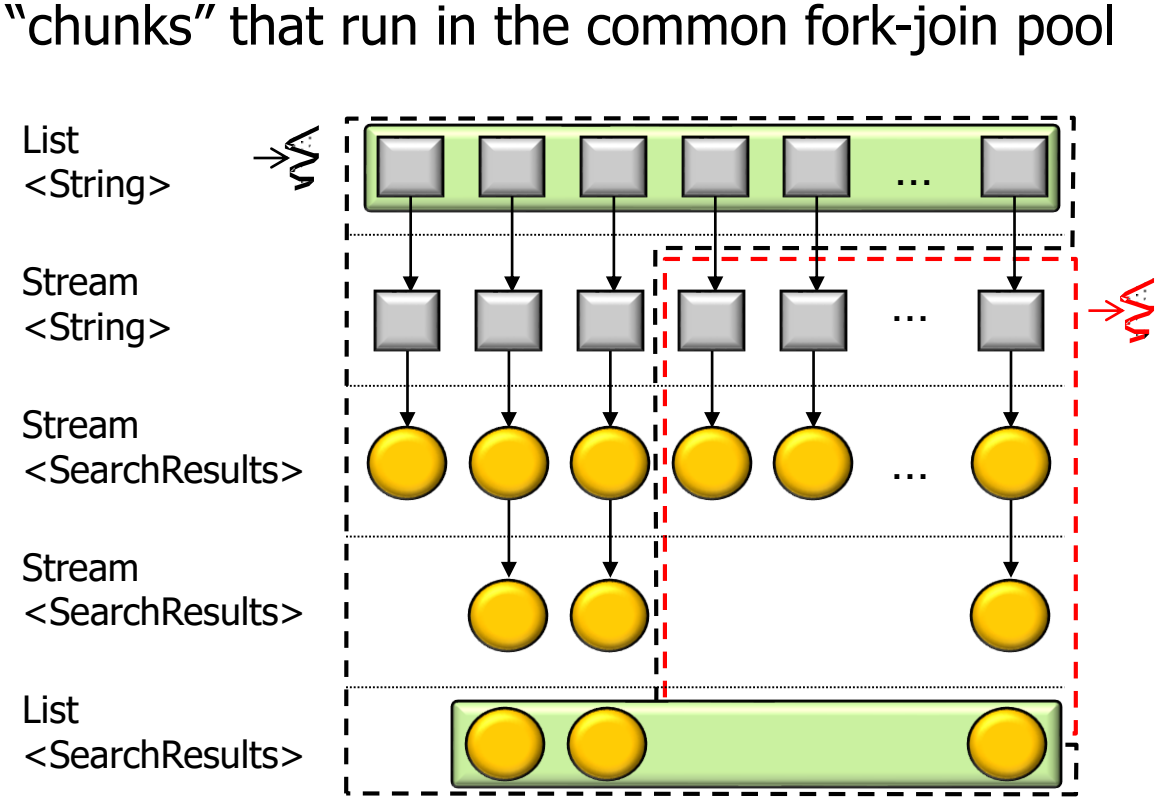
- By default, a stream executes sequentially, so all its aggregate operations run behaviors in a single thread of control

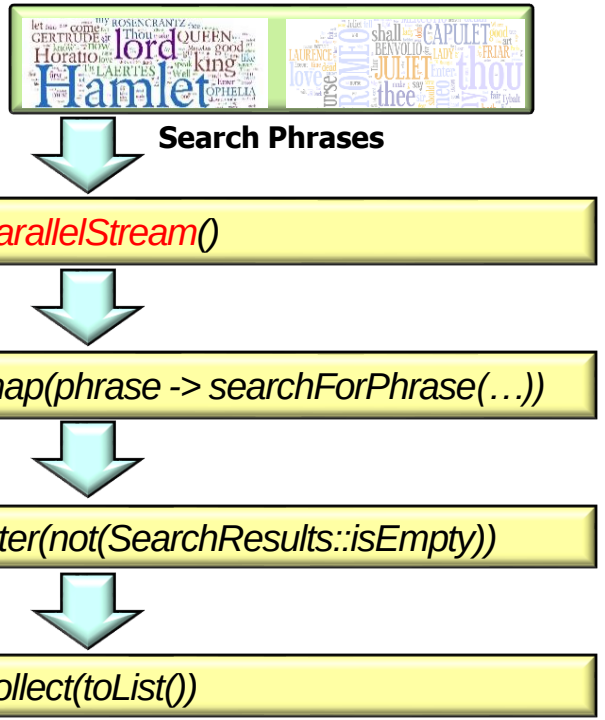




Transitioning from Sequential Streams to Parallel Streams

- When a stream executes in parallel, it is partitioned into multiple substream "chunks" that run in the common fork-join pool





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

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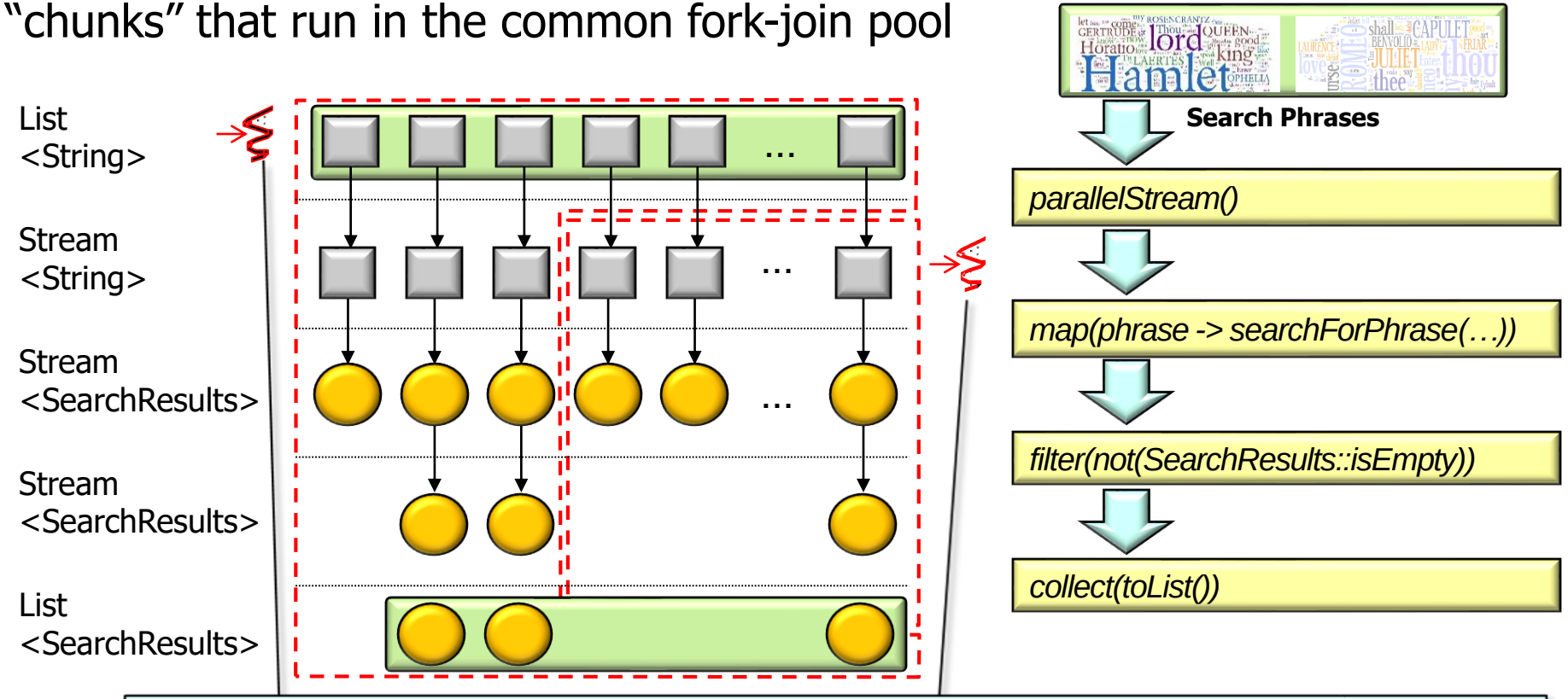

Threads in the fork-join pool (non-deterministically) process different chunks

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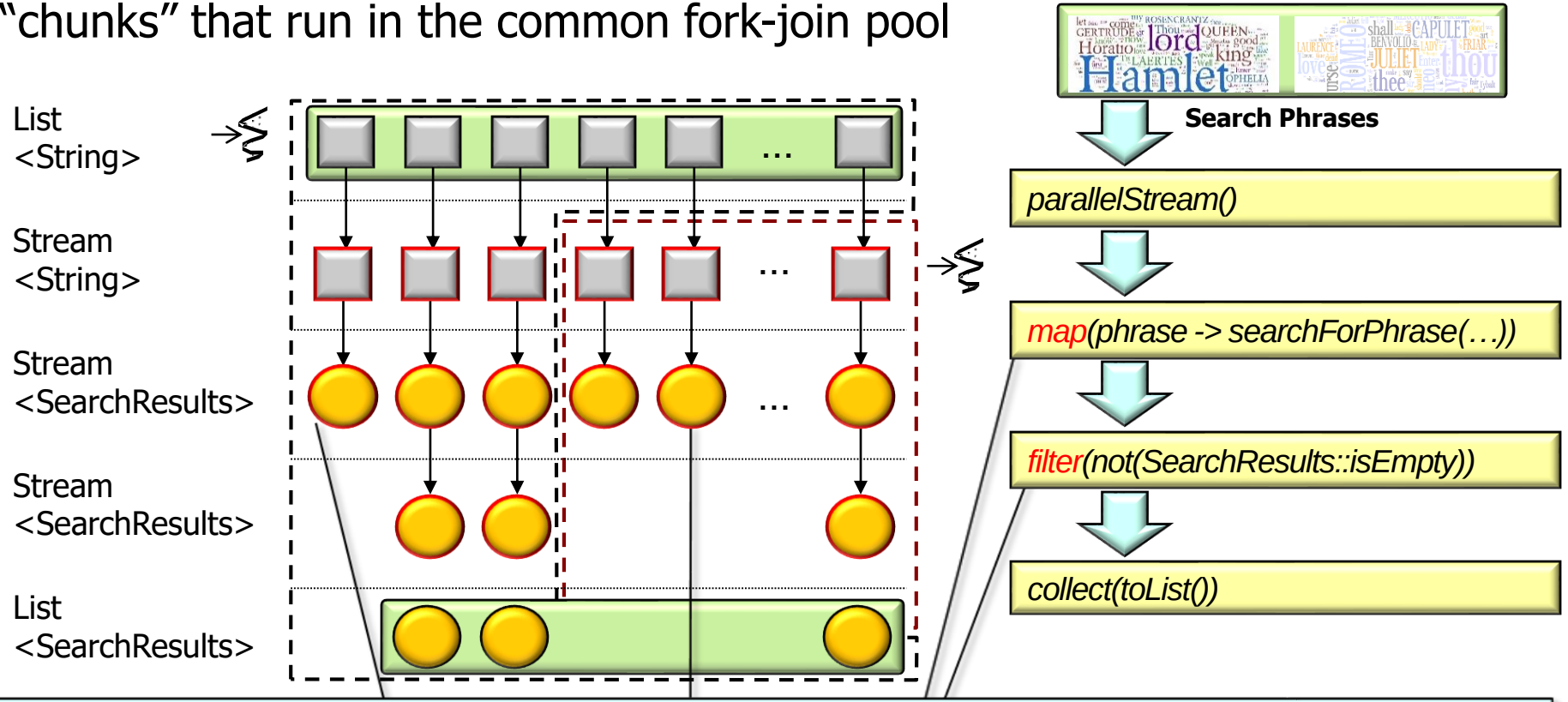

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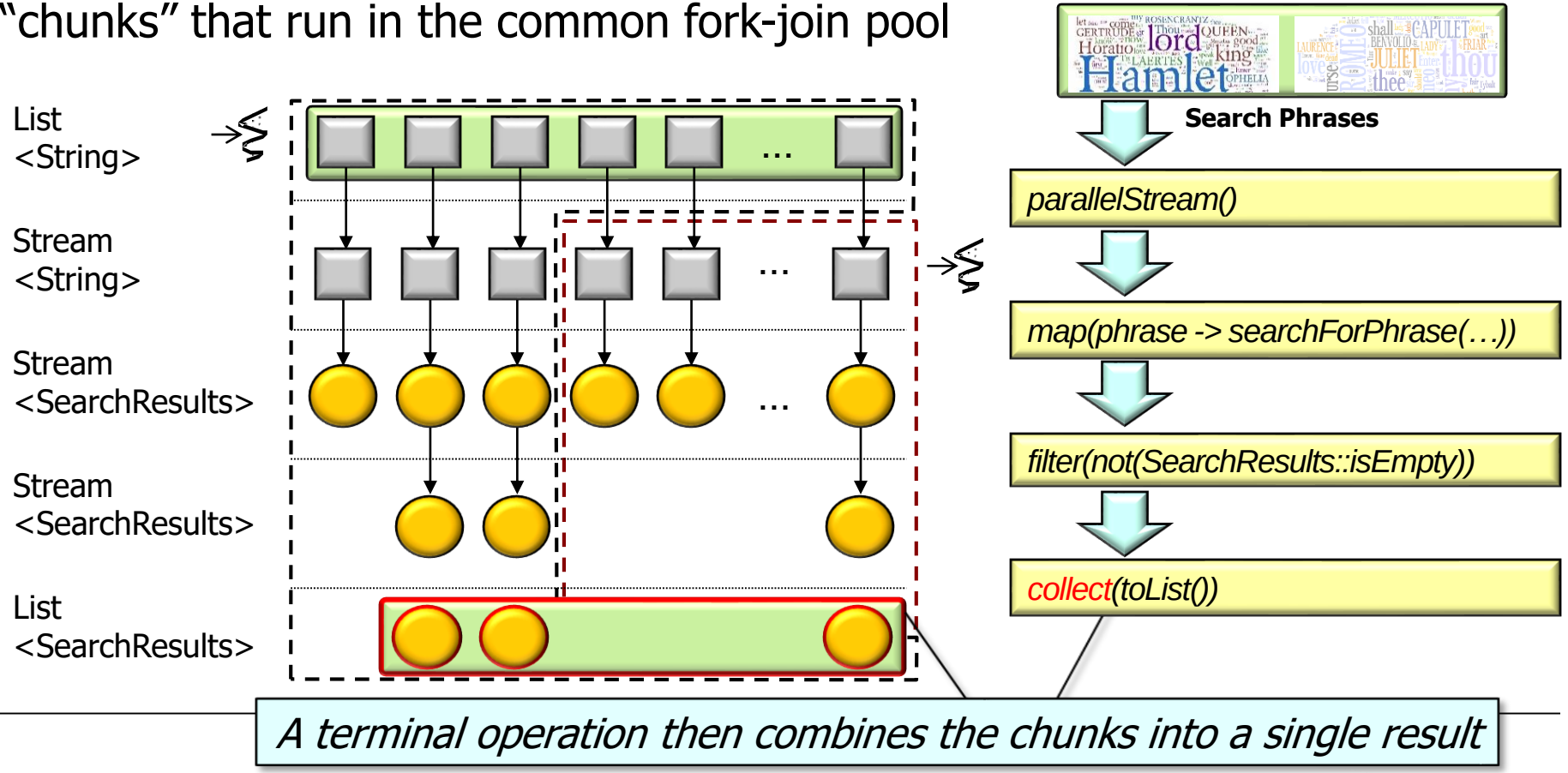

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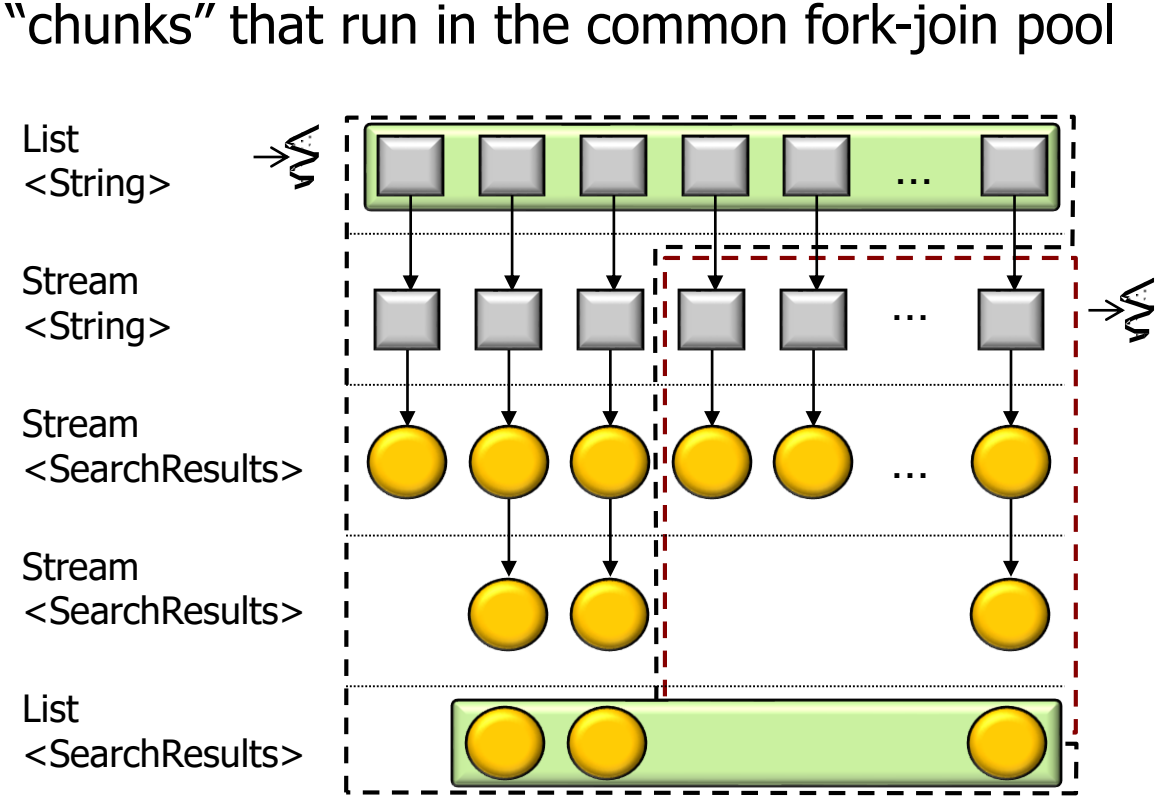

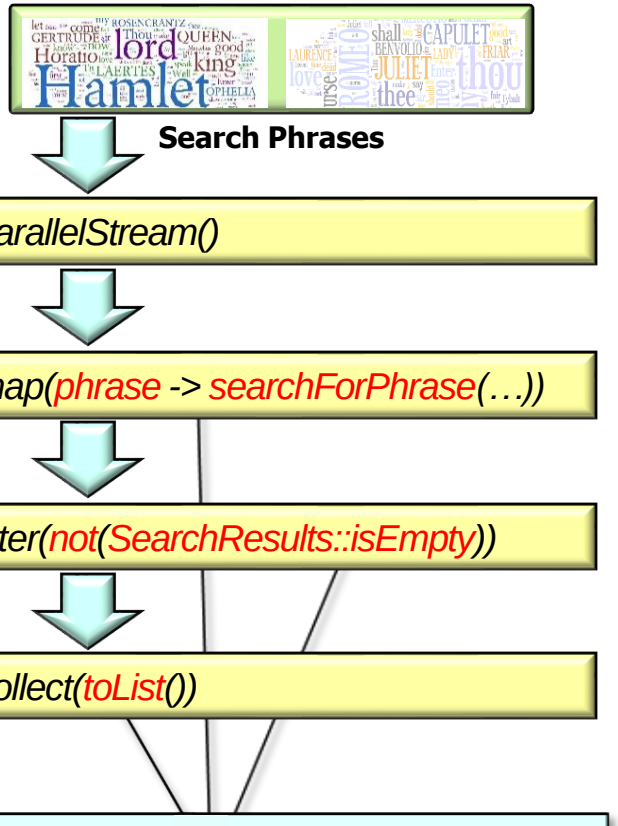

(Stateless) Java 8 lambda expressions & method references are used to pass behaviors

Transitioning from Sequential Streams to Parallel Streams

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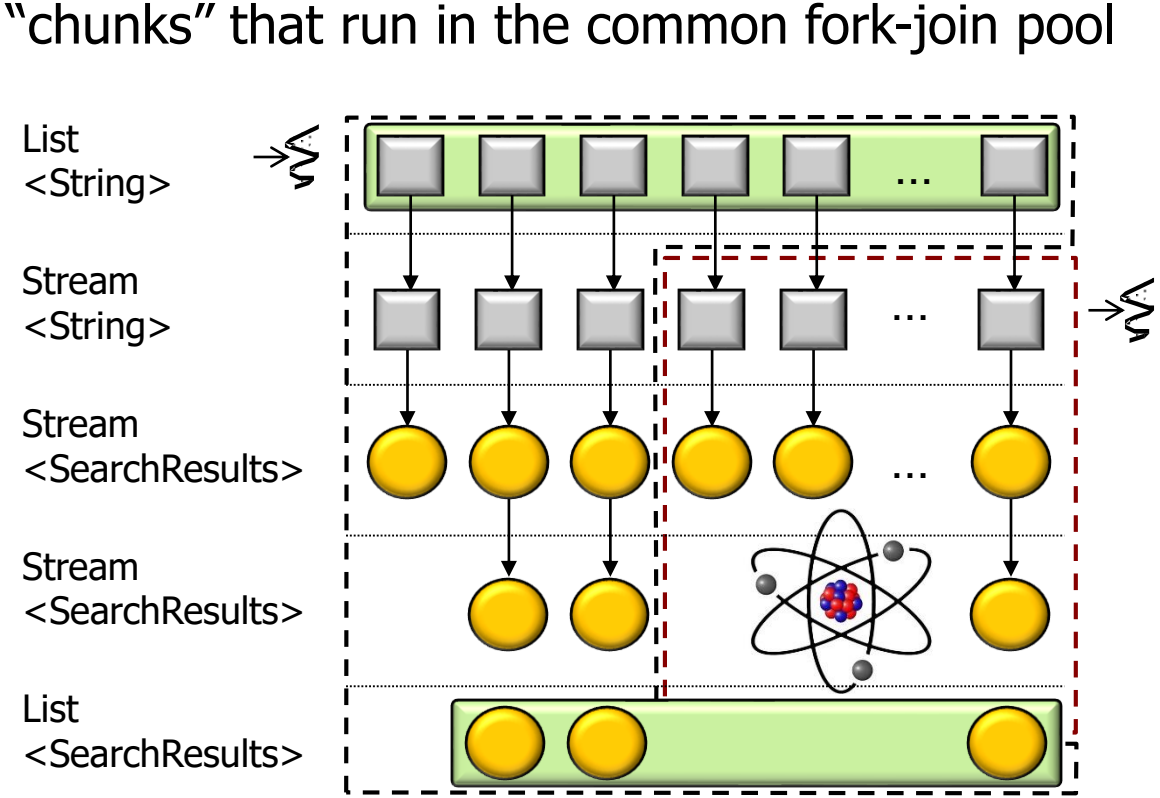

stream() vs. parallelStream()

map(phrase -> searchForPhrase(…))

filter(not(SearchResults::isEmpty))

collect(toList())

Ideally, minuscule changes needed to transition from sequential to parallel stream

Transitioning from Sequential Streams to Parallel Streams

- The same aggregate operations can be used for sequential & parallel streams

Modifier and Type	Method and Description
boolean	`allMatch(Predicate<? super T> predicate)` Returns whether all elements of this stream match the provided predicate.
boolean	`anyMatch(Predicate<? super T> predicate)` Returns whether any elements of this stream match the provided predicate.
static <T> Stream.Builder<T>	`builder()` Returns a builder for a Stream.
<R,A> R	`collect(Collector<? super T,A,R> collector)` Performs a **mutable reduction** operation on the elements of this stream using a Collector.
<R> R	`collect(Supplier<R> supplier, BiConsumer<R,? super T> accumulator, BiConsumer<R,R> combiner)` Performs a **mutable reduction** operation on the elements of this stream.
static <T> Stream<T>	`concat(Stream<? extends T> a, Stream<? extends T> b)` Creates a lazily concatenated stream whose elements are all the elements of the first stream followed by all the elements of the second stream.
long	`count()` Returns the count of elements in this stream.
Stream<T>	`distinct()` Returns a stream consisting of the distinct elements (according to `Object.equals(Object)`) of this stream.
static <T> Stream<T>	`empty()` Returns an empty sequential Stream.
Stream<T>	`filter(Predicate<? super T> predicate)` Returns a stream consisting of the elements of this stream that match the given predicate.
Optional<T>	`findAny()` Returns an Optional describing some element of the stream, or an empty Optional if the stream is empty.
Optional<T>	`findFirst()` Returns an Optional describing the first element of this stream, or an empty Optional if the stream is empty.
<R> Stream<R>	`flatMap(Function<? super T,? extends Stream<? extends R>> mapper)` Returns a stream consisting of the results of replacing each element of this stream with the contents of a mapped stream produced by applying the provided mapping function to each element.

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

Transitioning from Sequential Streams to Parallel Streams

- The same aggregate operations can be used for sequential & parallel streams

e.g., SearchStreamGang uses the same aggregate operations for both SearchWithSequentialStreams & SearchWithParallelStreams implementations

stream() vs. parallelStream()

map(phrase -> searchForPhrase(…))

filter(not(SearchResults::isEmpty))

collect(toList())

<<Java Class>>
SearchWithSequentialStreams
processStream():List<List<SearchResults>>
processInput(String):List<SearchResults>

<<Java Class>>
SearchWithParallelStreams
processStream():List<List<SearchResults>>
processInput(CharSequence):List<SearchResults>

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

Transitioning from Sequential Streams to Parallel Streams

- The same aggregate operations can be used for sequential & parallel streams
  - Java streams can thus treat parallelism as an optimization & leverage all available cores!

Search Phrases

parallelStream()

map(phrase -> searchForPhrase(…))

filter(not(SearchResults::isEmpty))

collect(toList())

See qconlondon.com/london-2017/system/files/presentation-slides/concurrenttoparallel.pdf

Transitioning from Sequential Streams to Parallel Streams

- The same aggregate operations can be used for sequential & parallel streams
  - Java streams can thus treat parallelism as an optimization & leverage all available cores!
  - Naturally, behaviors run by these aggregate operations must be designed carefully to avoid accessing unsynchronized shared state..


```
parallelStream()
map(phrase -> searchForPhrase(…))
filter(not(SearchResults::isEmpty))
collect(toList())
```

See henrikeichenhardt.blogspot.com/2013/06/why-shared-mutable-state-is-root-of-all.html

End of Overview of Java Parallel Streams: Transitioning to Parallelism