Overview of the Java Search WithParallelSpliterator Case Study

Douglas C. Schmidt

d.schmidt@vanderbilt.edu

www.dre.vanderbilt.edu/~schmidt

Professor of Computer Science

Institute for Software Integrated Systems

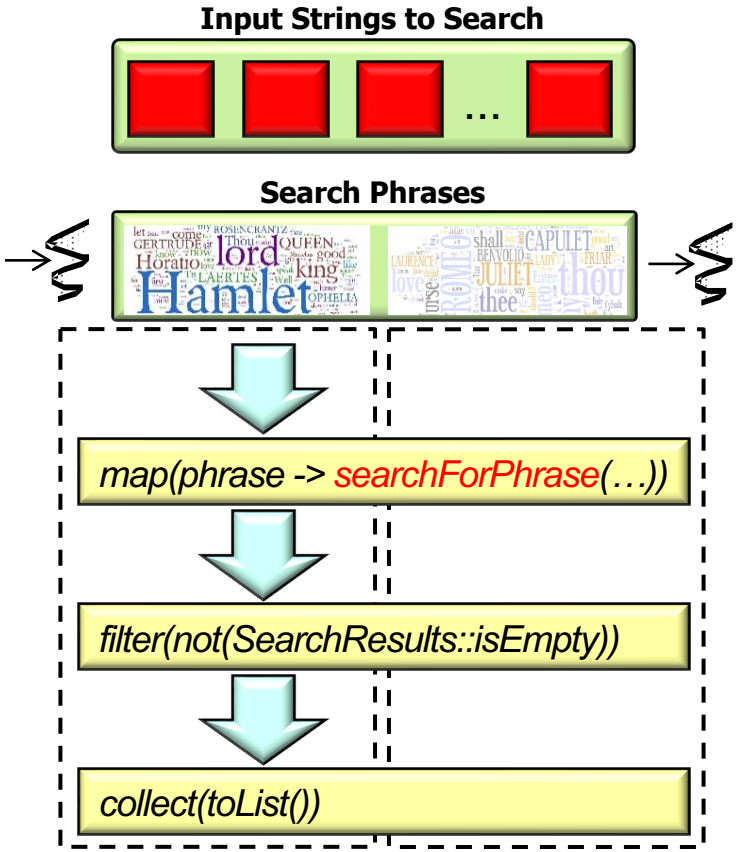
Vanderbilt University

Nashville, Tennessee, USA

Learning Objectives in this Part of the Lesson

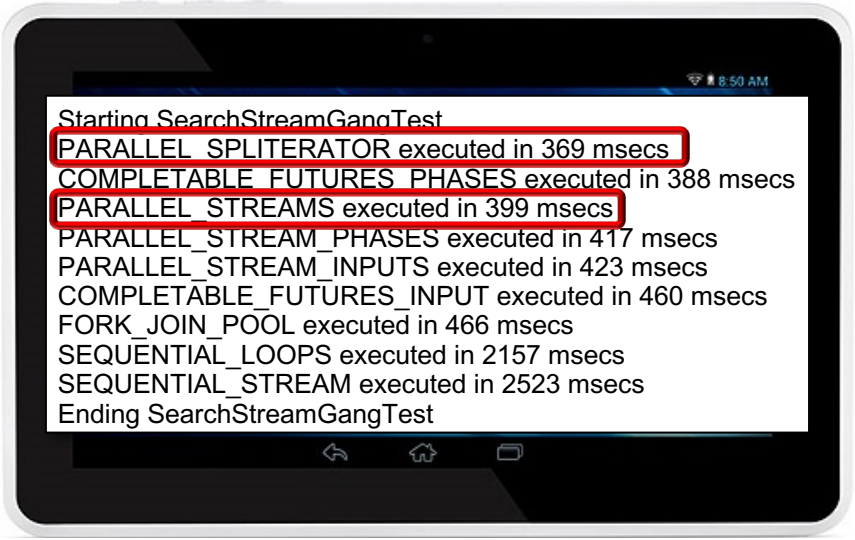
- Understand how a parallel spliterator can improve parallel stream performance

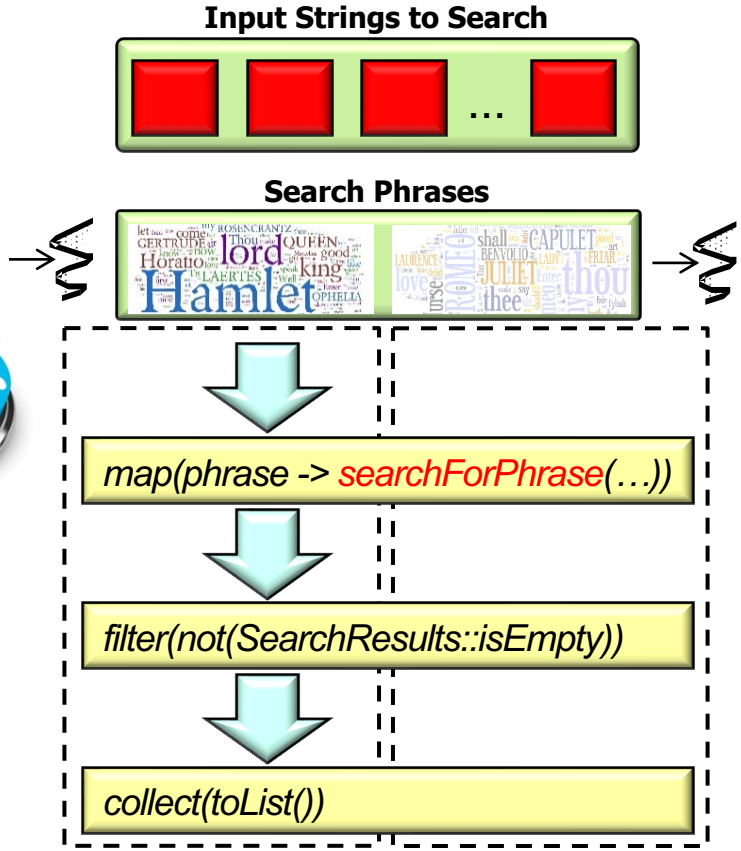
```
SearchResults searchForPhrase
   (..., boolean parallel) {
   return new SearchResults
      (..., StreamSupport.stream
        (new PhraseMatchSpliterator(...),
         parallel)
        .collect(toList()));
}
```



Learning Objectives in this Part of the Lesson

- Understand how a parallel spliterator can improve parallel stream performance
  - This solution fixes a "con" (limited performance) covered earlier



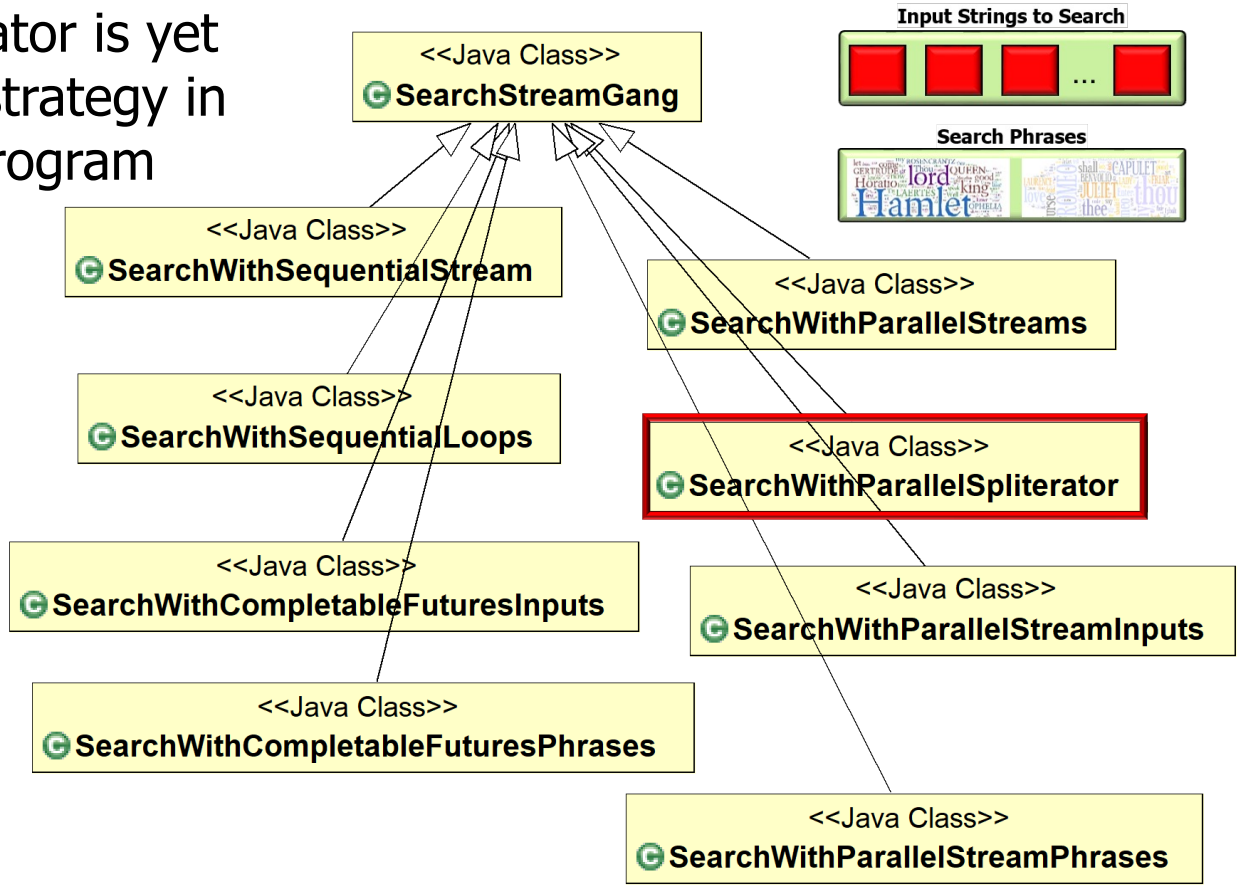


See *"Java SearchWithParallelStreams Example"*

Overview of SearchWith ParallelSpliterator

Overview of SearchWithParallelSpliterator

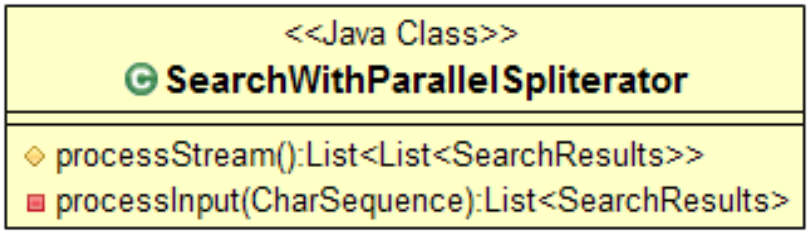
- SearchWithParallelSpliterator is yet another implementation strategy in the SearchStreamGang program



See SearchStreamGang/src/main/java/livelessons/streamgangs/SearchWithParallelSpliterator.java

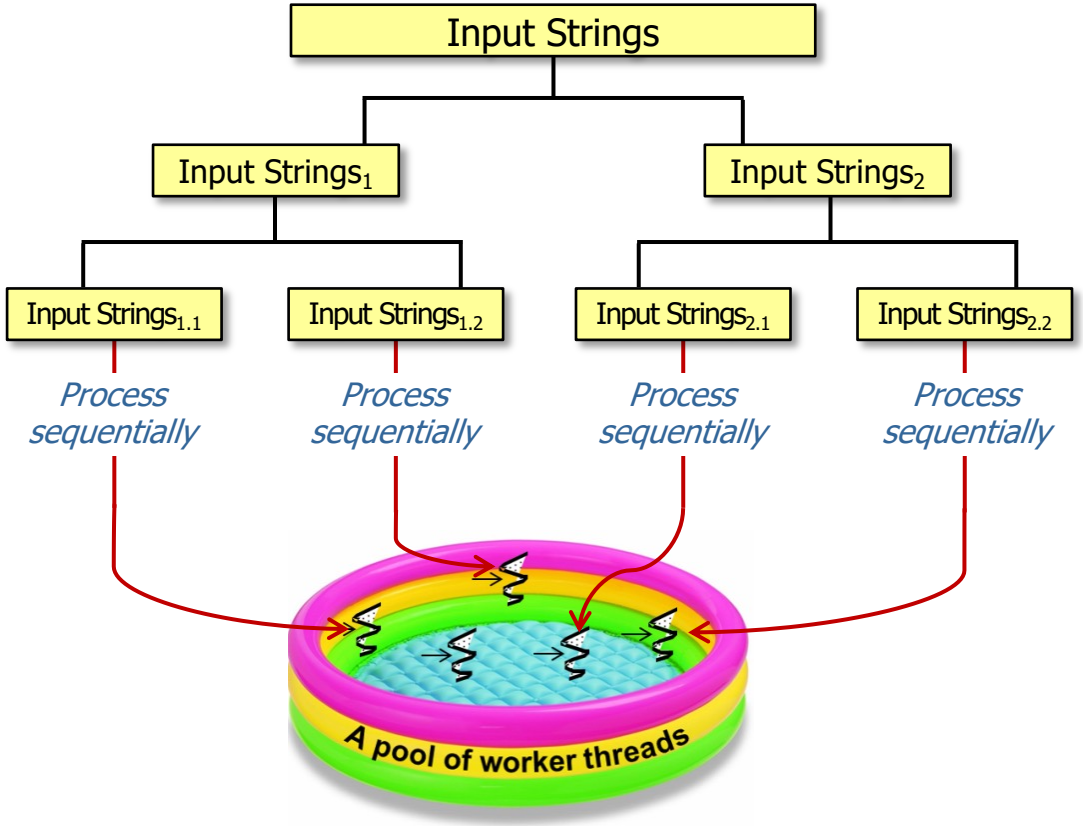
Overview of SearchWithParallelSpliterator

- SearchWithParallelSpliterator uses parallel streams in three ways



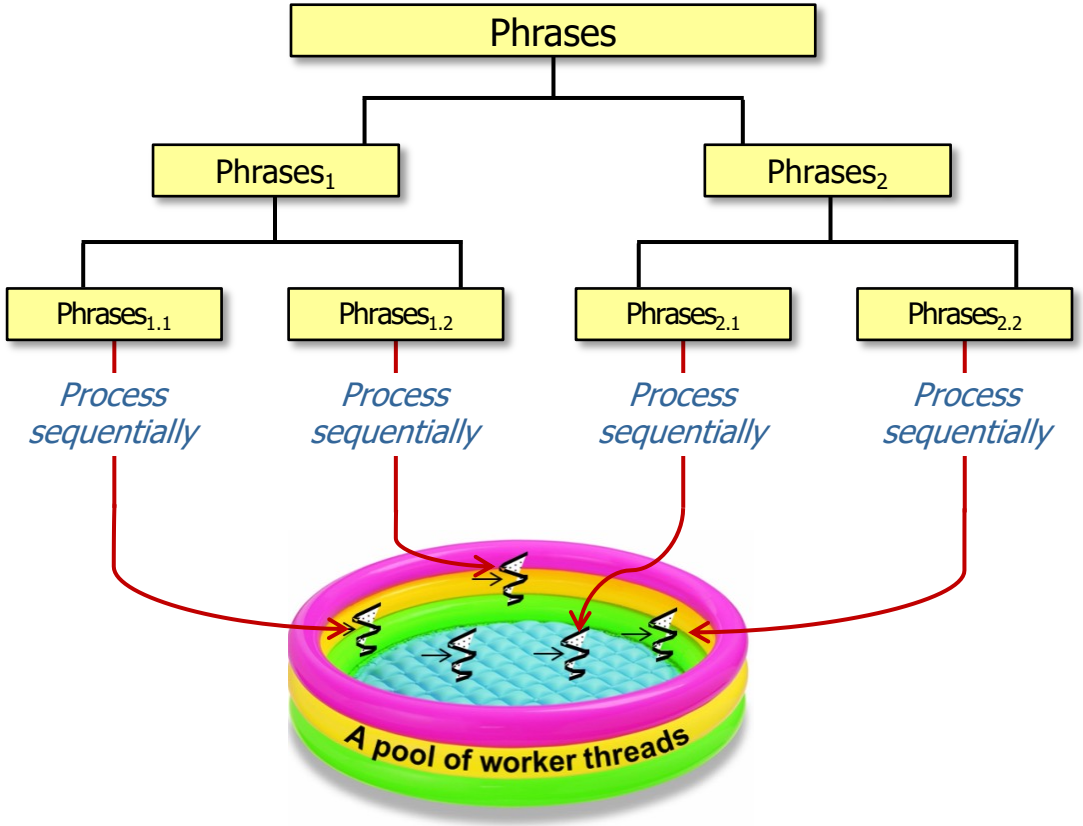
Overview of SearchWithParallelSpliterator

- SearchWithParallelSpliterator uses parallel streams in three ways
  - Search chunks of input in parallel



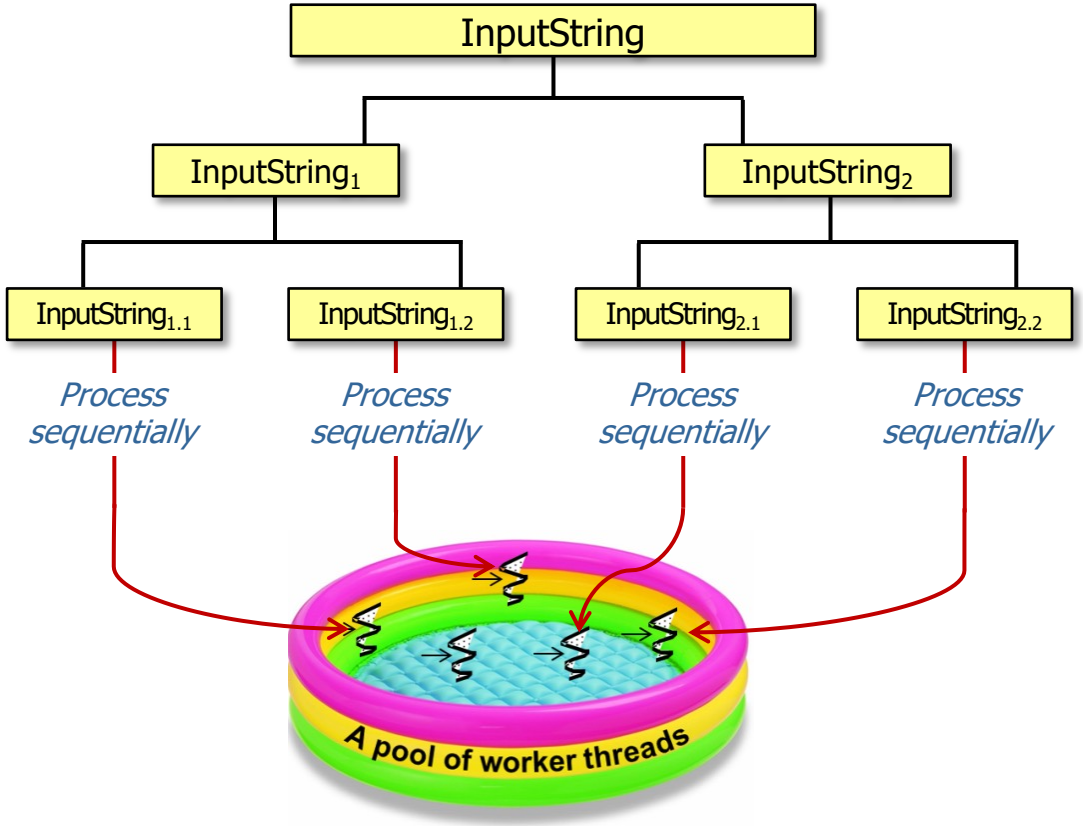
Overview of SearchWithParallelSpliterator

- SearchWithParallelSpliterator uses parallel streams in three ways
  - Search chunks of input in parallel
  - Search chunks of phrases in parallel



Overview of SearchWithParallelSpliterator

- SearchWithParallelSpliterator uses parallel streams in three ways
  - Search chunks of input in parallel
  - Search chunks of phrases in parallel
  - Search chunks of *each* input string in parallel



Overview of SearchWithParallelSpliterator

- SearchWithParallelSpliterator uses parallel streams in three ways
  - Search chunks of input in parallel
  - Search chunks of phrases in parallel
  - Search chunks of *each* input string in parallel

SearchWithParallelSpliterator is thus the most aggressive parallelism strategy!

Overview of SearchWithParallelSpliterator

- The relative contribution of each parallel streams model is shown here:

Time for 38 strings = 462 ms (parallelSpliterator|parallelPhrases|parallelInput)

Time for 38 strings = 470 ms (sequentialSpliterator|parallelPhrases|parallelInput)

Time for 38 strings = 477 ms (sequentialSpliterator|parallelPhrases|sequentialInput)

Time for 38 strings = 490 ms (parallelSpliterator|parallelPhrases|sequentialInput)

Time for 38 strings = 498 ms (parallelSpliterator|sequentialPhrases|parallelInput)

Time for 38 strings = 510 ms (sequentialSpliterator|sequentialPhrases|parallelInput)

Time for 38 strings = 1326 ms (parallelSpliterator|sequentialPhrases|sequentialInput)

Time for 38 strings = 2463 ms (sequentialSpliterator|sequentialPhrases|sequentialInput)

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

Overview of SearchWithParallelSpliterator

- The relative contribution of each parallel streams model is shown here:

Time for 38 strings = 462 ms (parallelSpliterator|parallelPhrases|parallelInput)

Time for 38 strings = 470 ms (sequentialSpliterator|parallelPhrases|parallelInput)

Time for 38 strings = 477 ms (sequentialSpliterator|parallelPhrases|sequentialInput)

Time for 38 strings = 490 ms (parallelSpliterator|parallelPhrases|sequentialInput)

Time for 38 strings = 498 ms (parallelSpliterator|sequentialPhrases|parallelInput)

Time for 38 strings = 510 ms (sequentialSpliterator|sequentialPhrases|parallelInput)

Time for 38 strings = 1326 ms (parallelSpliterator|sequentialPhrases|sequentialInput)

Time for 38 strings = 2463 ms (sequentialSpliterator|sequentialPhrases|sequentialInput)

Tests conducted on a 2.6 GHz six-core Lenovo P52 with 64 Gbytes of RAM

Overview of SearchWithParallelSpliterator

- Longer input strings leverage the parallel spliterator even better:

Time for 2 strings = 452 ms (parallelSpliterator|parallelPhrases|parallelInput)

Time for 2 strings = 462 ms (sequentialSpliterator|parallelPhrases|parallelInput)

Time for 2 strings = 466 ms (sequentialSpliterator|parallelPhrases|sequentialInput)

Time for 2 strings = 478 ms (parallelSpliterator|parallelPhrases|sequentialInput)

Time for 2 strings = 788 ms (parallelSpliterator|sequentialPhrases|parallelInput)

Time for 2 strings = 1298 ms (sequentialSpliterator|sequentialPhrases|parallelInput)

Time for 2 strings = 1488 ms (parallelSpliterator|sequentialPhrases|sequentialInput)

Time for 2 strings = 2467 ms (sequentialSpliterator|sequentialPhrases|sequentialInput)

Longer strings may provide better opportunity to leverage benefits of parallelism

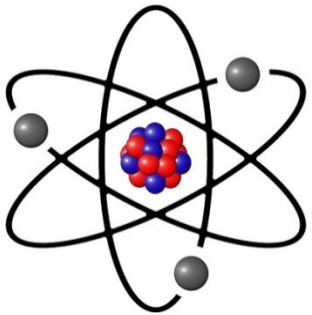
Overview of SearchWithParallelSpliterator

- SearchWithParallelSpliterator processInput() has just one minuscule change

```
List<SearchResults> processInput(CharSequence inputSeq) {
  String title = getTitle(inputString);
  CharSequence input = inputSeq.subSequence(...);

  List<SearchResults> results = mPhrasesToFind
    .parallelStream()
    .map(phase ->
         searchForPhrase(phase, input, title, true))
    .filter(not(SearchResults::isEmpty))

    .collect(toList());
  return results;
}
```



The value of "true" triggers the use of a parallel search for a phrase in an input string

Overview of SearchWithParallelSpliterator

- searchForPhrase() uses a parallel spliterator to break the input into "chunks" that are processed in parallel

```
SearchResults searchForPhrase(String phrase, CharSequence input,
                              String title, boolean parallel) {
  return new SearchResults
    (..., ..., phrase, title, StreamSupport
     .stream(new PhraseMatchSpliterator(input, phrase),
             parallel)
     .collect(toList()));
}
```

See livelessons/streamgangs/SearchStreamGang.java

Overview of SearchWithParallelSpliterator

- searchForPhrase() uses a parallel spliterator to break the input into "chunks" that are processed in parallel

```
SearchResults searchForPhrase(String phrase, CharSequence input,
                              String title, boolean parallel) {
  return new SearchResults
    (..., ..., phrase, title, StreamSupport
     .stream(new PhraseMatchSpliterator(input, phrase),
             parallel)
     .collect(toList()));
  }
```

StreamSupport.stream() creates a sequential or parallel stream via PhraseMatchSpliterator

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

Overview of SearchWithParallelSpliterator

- searchForPhrase() uses a parallel spliterator to break the input into "chunks" that are processed in parallel

```
SearchResults searchForPhrase(String phrase, CharSequence input,
                              String title, boolean parallel) {
  return new SearchResults
    (..., ..., phrase, title, StreamSupport
     .stream(new PhraseMatchSpliterator(input, phrase),
             parallel)
     .collect(toList()));
  }
```

The value of "parallel" is true when searchForPhrase() is called in the SearchWithParallelSpliterator program

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

Overview of SearchWithParallelSpliterator

- searchForPhrase() uses a parallel spliterator to break the input into "chunks" that are processed in parallel

```
SearchResults searchForPhrase(String phrase, CharSequence input,
                              String title, boolean parallel) {
  return new SearchResults
    (..., ..., phrase, title, StreamSupport
     .stream(new PhraseMatchSpliterator(input, phrase),
             parallel)
     .collect(toList()));
  }
```

We now focus in depth on the PhraseMatchSpliterator methods

See the rest of the lessons on "*Java SearchWithParallelSpliterator Example*"

End of Overview of the Java SearchWithParallelSpliterator Case Study