Common Programming Hazards with Java Parallel Streams

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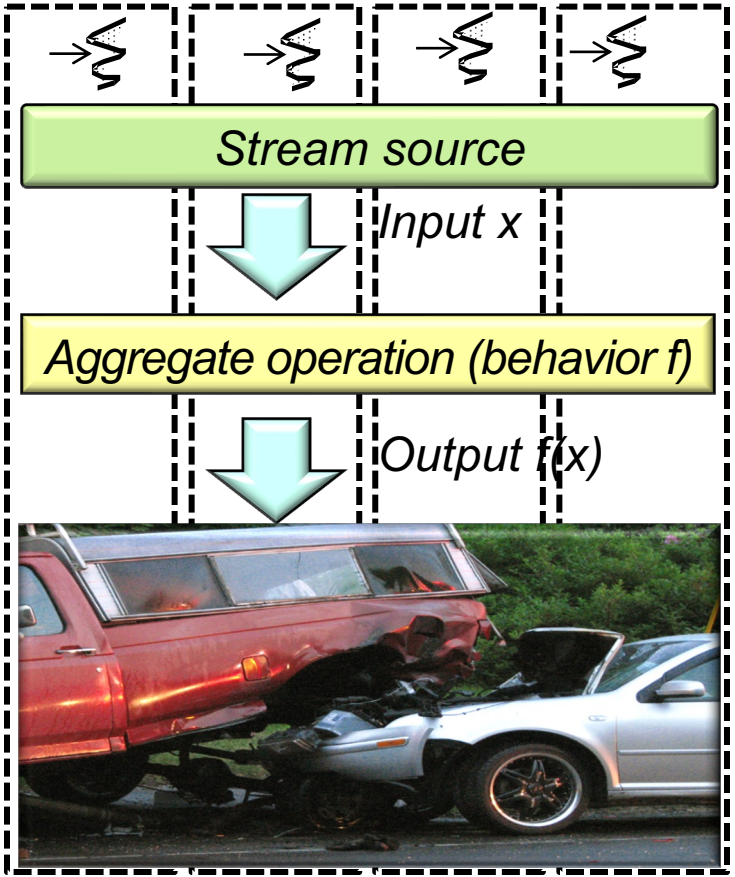
Learning Objectives in this Part of the Lesson

- Understand the structure & functionality of Java streams, e.g.,
  - Fundamentals of streams
  - Benefits of streams
  - Creating a stream
  - Aggregate operations in a stream
  - Applying streams in practice
  - Sequential vs. parallel streams
  - Common programming hazards of parallel streams



Common Programming Hazards for Parallel Streams

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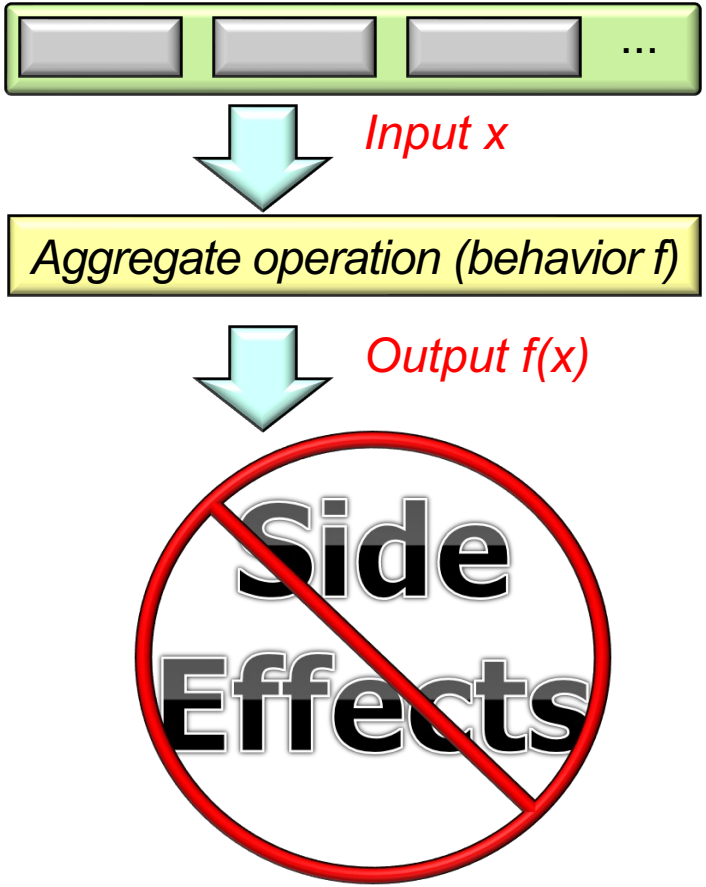
- Ideally, a behavior's output in a stream depends only on its input arguments



See en.wikipedia.org/wiki/Side_effect_(computer_science)

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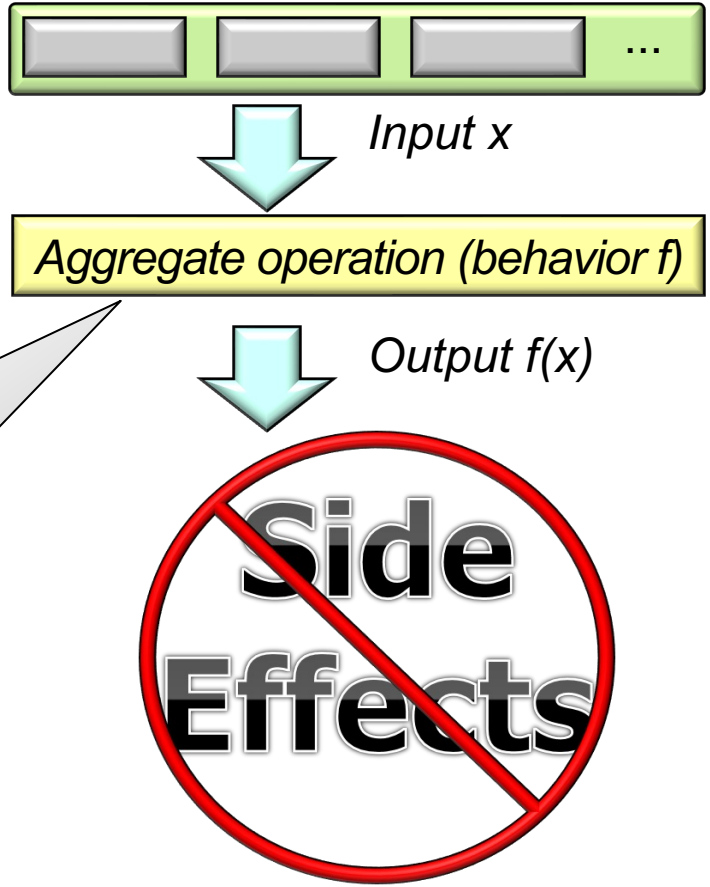


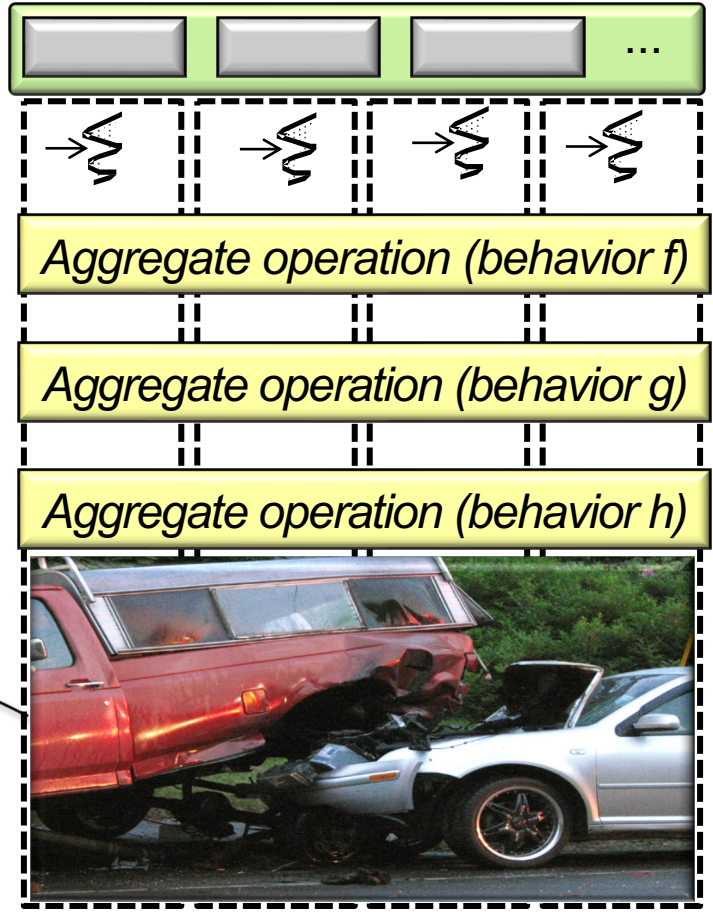

```
String capitalize(String s) {
  if (s.length() == 0)
    return s;
  return s.substring(0, 1)
          .toUpperCase()
        + s.substring(1)
           .toLowerCase();
```

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

Common Programming Hazards for Parallel Streams

- Ideally, a behavior's output in a stream depends only on its input arguments
  - Behaviors with side-effects can incur race conditions in parallel streams

Race conditions arise in software when an application depends on the sequence or timing of threads for it to operate properly



See en.wikipedia.org/wiki/Race_condition#Software

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```
long factorial(long n) {
  Total t = new Total();
  LongStream
    .rangeClosed(1, n)
    .parallel()
    .forEach(t::mult);
  return t.mTotal;
}
```

```
class Total {
  public long mTotal = 1;

  public void mult(long n)
  { mTotal *= n; }
}
```

A buggy attempt to compute the 'nth' factorial in parallel

See github.com/douglascraigschmidt/LiveLessons/tree/master/Java8/ex16

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Shared mutable state

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

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Generate a range of values from 1..n

```
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}
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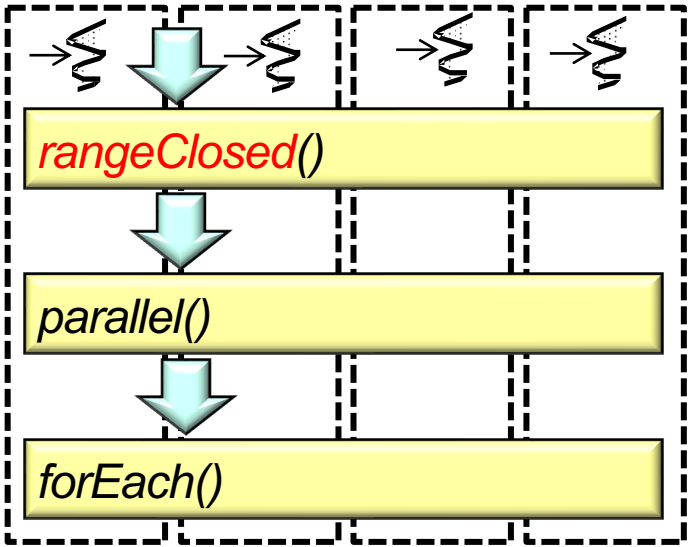

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Run in parallel

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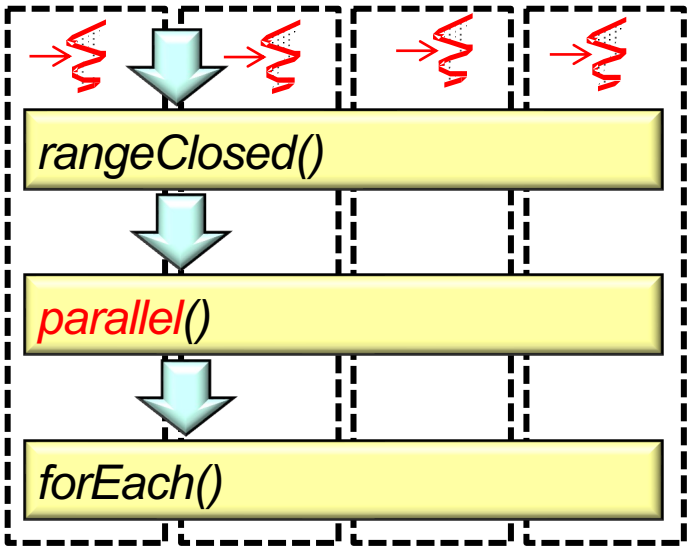

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Multiply the running total w/the latest value

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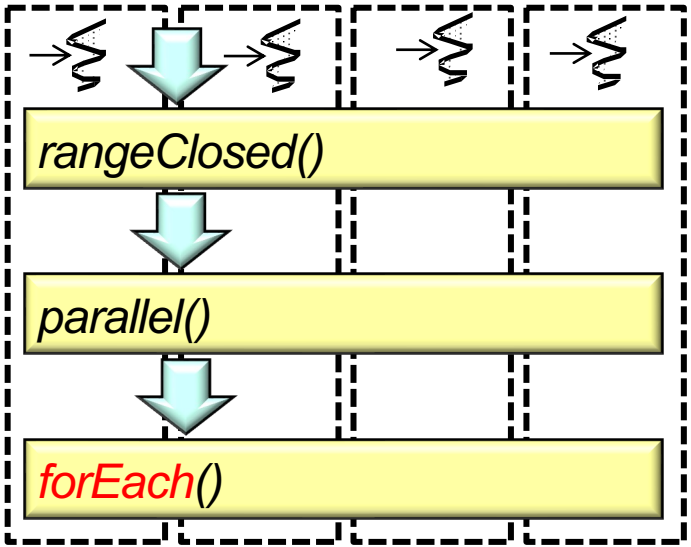

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Beware of race conditions!!!

See en.wikipedia.org/wiki/Race_condition#Software

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Beware of inconsistent memory visibility

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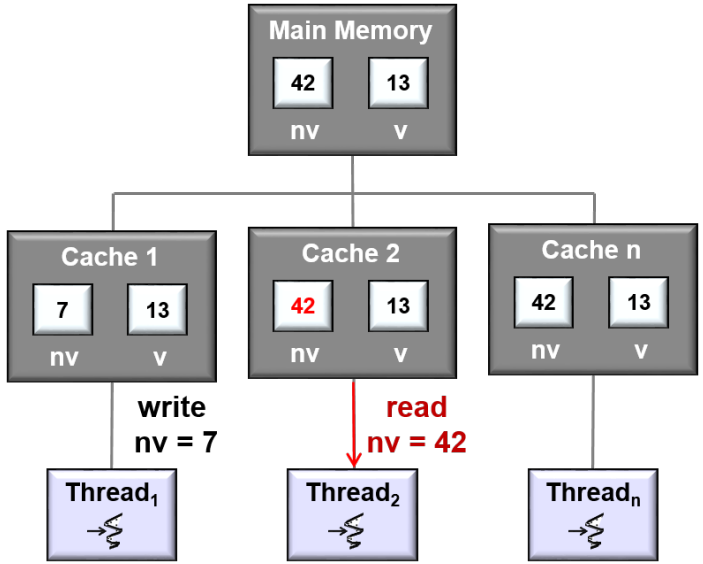

See jeremymanson.blogspot.com/2007/08/atomicity-visibility-and-ordering.html

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Only you can prevent concurrency hazards!

In Java *you* must avoid these hazards, i.e., the compiler & JVM won't save you..

End of Common Programming Hazards of Java Parallel Streams