Learn How Java Reactive Streams Map Onto Reactive Programming Principles

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Learning Objectives in this Part of the Lesson

- Understand the key benefits & principles underlying reactive programming
- Know the Java reactive streams API & popular implementations of this API
- Learn how Java reactive streams maps to key reactive programming principles
Mapping Reactive Streams to Reactive Programming Principles
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- Mapping reactive programming principles onto reactive streams features, e.g.

- **Responsive**
  - Avoid blocking caller code
  - Blocking underutilizes cores, impedes inherent parallelism, & complicates program structure

<table>
<thead>
<tr>
<th>CALLER</th>
<th>CALLEE</th>
</tr>
</thead>
<tbody>
<tr>
<td>searchForWord₁</td>
<td>return result₁</td>
</tr>
<tr>
<td></td>
<td>searchForWord₂</td>
</tr>
<tr>
<td></td>
<td>return result₂</td>
</tr>
<tr>
<td></td>
<td>searchForWord₃</td>
</tr>
<tr>
<td></td>
<td>return return₃</td>
</tr>
</tbody>
</table>

Mapping Reactive Streams to Reactive Programming Principles

- Mapping reactive programming principles onto reactive streams features, e.g.

  - **Responsive**
    - Avoid blocking caller code
      - Blocking underutilizes cores, impedes inherent parallelism, & complicates program structure

    Methods like `subscribeOn()`, `publishOn()`, & `observeOn()` can be used to avoid blocking caller code

See [spring.io/blog/2019/12/13/flight-of-the-flux-3-hopping-threads-and-schedulers](http://spring.io/blog/2019/12/13/flight-of-the-flux-3-hopping-threads-and-schedulers)
Mapping Reactive Streams to Reactive Programming Principles

- Mapping reactive programming principles onto reactive streams features, e.g.
  - **Responsive**
    - Avoid blocking caller code
    - Avoid changing threads
    - Incurs excessive overhead wrt synchronization, context switching, & memory/cache management

See gee.cs.oswego.edu/dl/papers/fj.pdf
Mapping Reactive Streams to Reactive Programming Principles

- Mapping reactive programming principles onto reactive streams features, e.g.
  - **Responsive**
    - Avoid blocking caller code
    - Avoid changing threads
      - Incurs excessive overhead wrt synchronization, context switching, & memory/cache management

Methods like `subscribeOn()`, `publishOn()`, & `observeOn()` provide fine-grained control over mapping events to threads

See zoltanaltfatter.com/2018/08/26/subscribeOn-publishOn-in-Reactor
Mapping Reactive Streams to Reactive Programming Principles

- Mapping reactive programming principles onto reactive streams features, e.g.
  - Responsive
  - Resilient
    - Exception methods make more programs resilient to failures

Exceptions decouple error processing from normal operations

Reactive streams are localized to a single process, *not* a cluster!
Mapping Reactive Streams to Reactive Programming Principles

- Mapping reactive programming principles onto reactive streams features, e.g.

  - **Responsive**
  - **Resilient**
  - **Elastic**

- Async computations can run scalably in a pool of threads atop a set of cores

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RxJava schedulers support many types of threads and/or thread pools

See [www.baeldung.com/rxjava-schedulers](http://www.baeldung.com/rxjava-schedulers)
Mapping Reactive Streams to Reactive Programming Principles

- Mapping reactive programming principles onto reactive streams features, e.g.
  - Responsive
  - Resilient
  - Elastic
    - Async computations can run scalably in a pool of threads atop a set of cores

Reactor, like RxJava, can be considered to be concurrency-agnostic. That is, it does not enforce a concurrency model. Rather, it leaves you, the developer, in command. However, that does not prevent the library from helping you with concurrency.

Obtaining a Flux or a Mono does not necessarily mean that it runs in a dedicated Thread. Instead, most operators continue working in the Thread on which the previous operator executed. Unless specified, the topmost operator (the source) itself runs on the Thread in which the subscribe() call was made.

The following example runs a Mono in a new thread:

```java
public static void main(String[] args) throws InterruptedException {
    final Mono<String> mono = Mono.just("hello ");

    Thread t = new Thread(() -> mono
        .map(msg -> msg + " thread ")
        .subscribe(v -> System.out.println(v + Thread.currentThread().getName()))
    );

    t.start();
    t.join();
}
```

Project Reactor’s schedulers also support various types of threads and/or thread pools

See [projectreactor.io/docs/core/release/reference/#schedulers](http://projectreactor.io/docs/core/release/reference/#schedulers)
Mapping Reactive Streams to Reactive Programming Principles

- Mapping reactive programming principles onto reactive streams features, e.g.
  - Responsive
  - Resilient
  - Elastic
  - Message-driven
    - Implementations of reactive streams & Java-based thread pools pass messages internally

  e.g., Java’s fork-join pool supports “work-stealing” between deques

See en.wikipedia.org/wiki/Work_stealing
End of Learn How Java Reactive Streams Map Onto Reactive Programming Principles