Key Concurrency & Scheduler Operators in the Flux Class (Part 2)

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Learning Objectives in this Part of the Lesson

- Recognize key Flux operators
  - Factory method operators
  - Transforming operators
  - Concurrency & scheduler operators
    - These operators arrange to run other operators in designated threads & thread pools
      - e.g., Schedulers.parallel()

Key Scheduler Operators in the Flux Class

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- The Schedulers.parallel() operator
  - Hosts a fixed pool of single-threaded ExecutorService-based workers

```
static Scheduler
       parallel()
```

See projectreactor.io/docs/core/release/api/reactor/core/scheduler/Schedulers.html#parallel

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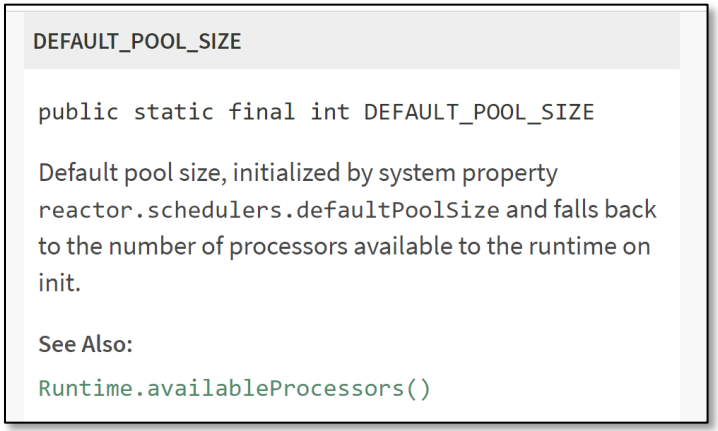
      - Size obtained by system property reactor.schedulers.defaultPoolSize



DEFAULT_POOL_SIZE

```
public static final int DEFAULT_POOL_SIZE
```

Default pool size, initialized by system property `reactor.schedulers.defaultPoolSize` and falls back to the number of processors available to the runtime on init.

See Also:

`Runtime.availableProcessors()`

See projectreactor.io/docs/core/release/api/reactor/core/scheduler/Schedulers.html#DEFAULT_POOL_SIZE

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availableProcessors

```
public int availableProcessors()
```

Returns the number of processors available to the Java virtual machine.

This value may change during a particular invocation of the virtual machine. Applications that are sensitive to the number of available processors should therefore occasionally poll this property and adjust their resource usage appropriately.

Returns:

the maximum number of processors available to the virtual machine; never smaller than one

Since:

1.4

See docs.oracle.com/javase/8/docs/api/java/lang/Runtime.html

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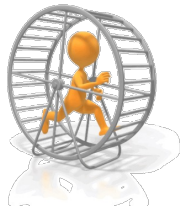
      - Optimized for computation-intensive non-blocking tasks due to its fixed-size



Class Schedulers

java.lang.Object
    reactor.core.scheduler.Schedulers

```
public abstract class Schedulers
extends Object
```

`Schedulers` provides various `Scheduler` flavors usable by `publishOn` or `subscribeOn`:

- `parallel()`: Optimized for fast `Runnable` non-blocking executions
- `single()`: Optimized for low-latency `Runnable` one-off executions
- `elastic()`: Optimized for longer executions, an alternative for blocking tasks where the number of active tasks (and threads) can grow indefinitely
- `boundedElastic()`: Optimized for longer executions, an alternative for blocking tasks where the number of active tasks (and threads) is capped
- `immediate()`: to immediately run submitted `Runnable` instead of scheduling them (somewhat of a no-op or "null object" `Scheduler`)
- `fromExecutorService(ExecutorService)` to create new instances around `Executors`

See projectreactor.io/docs/core/release/api/reactor/core/scheduler/Schedulers.html

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    - Optimized for computation-intensive non-blocking tasks due to its fixed-size
      - i.e., compute-/CPU-bound tasks, not I/O-bound tasks!

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Key Scheduler Operators in the Flux Class

- The Schedulers.parallel() operator
  - Hosts a fixed pool of single-threaded ExecutorService-based workers
  - Used for event-loops, callbacks, & other computational work

```
Flux
   .fromIterable(bigFractions)

   .flatMap
      (bf -> Mono
       .fromCallable(() -> bf
          multiply(bf))

       .subscribeOn
          (Schedulers.parallel()))

   .reduce(BigFraction::add)
```

Arrange to multiply a List of Big Integer objects in a background thread in computation thread pool

See Reactive/flux/ex3/src/main/java/FluxEx.java

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Each BigFraction emitted via from Callable() is multiplied in parallel within the computation thread pool

See Reactive/flux/ex3/src/main/java/FluxEx.java

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fromCallable() is a "lazy" factory method so multiply() runs in the computation thread pool even though subscribeOn() comes after

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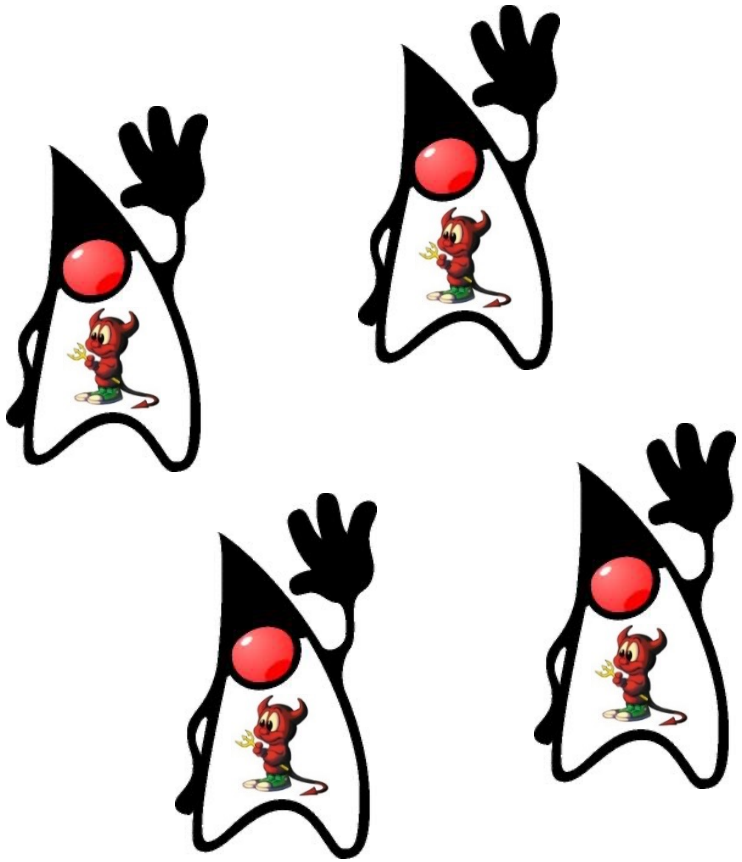
```

Only one thread runs reduce() after all other computations are done

Key Scheduler Operators in the Flux Class

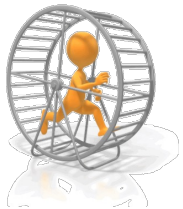
- The Schedulers.parallel() operator
  - Hosts a fixed pool of single-threaded ExecutorService-based workers
  - Used for event-loops, callbacks, & other computational work
  - Implemented via "daemon threads"
    - i.e., won't prevent the app from exiting even if its work isn't done



See www.baeldung.com/java-daemon-thread

Key Scheduler Operators in the Flux Class

- The Schedulers.parallel() operator
  - Hosts a fixed pool of single-threaded ExecutorService-based workers
  - Used for event-loops, callbacks, & other computational work
  - Implemented via "daemon threads"
- RxJava's Schedulers.computation() works in a similar way
  - i.e., it's fixed-size & intended for compute-intensive & non-blocking tasks



computation

```
@NonNull
public static @NonNull Scheduler computation()
```

Returns a default, shared `Scheduler` instance intended for computational work.

This can be used for event-loops, processing callbacks and other computational work.

It is not recommended to perform blocking, IO-bound work on this scheduler. Use `io()` instead.

The default instance has a backing pool of single-threaded `ScheduledExecutorService` instances equal to the number of available processors (`Runtime.availableProcessors()`) to the Java VM.

Unhandled errors will be delivered to the scheduler Thread's `Thread.UncaughtExceptionHandler`.

This type of scheduler is less sensitive to leaking `Scheduler.Worker` instances, although not disposing a worker that has timed/delayed tasks not cancelled by other means may leak resources and/or execute those tasks "unexpectedly".

If the `RxJavaPlugins.setFailOnNonBlockingScheduler(boolean)` is set to true, attempting to execute operators that block while running on this scheduler will throw an `IllegalStateException`.

See reactivex.io/RxJava/3.x/javadoc/io/reactivex/rxjava3/schedulers/Schedulers.html#computation

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- The Schedulers.parallel() operator
  - Hosts a fixed pool of single-threaded ExecutorService-based workers
  - Used for event-loops, callbacks, & other computational work
  - Implemented via "daemon threads"
  - RxJava's Schedulers.computation() works in a similar way
- The Java common fork-join pool is also similar wrt CPU-bound tasks

commonPool

```
public static ForkJoinPool commonPool()
```

Returns the common pool instance. This pool is statically constructed; its run state is unaffected by attempts to `shutdown()` or `shutdownNow()`. However this pool and any ongoing processing are automatically terminated upon program `System.exit(int)`. Any program that relies on asynchronous task processing to complete before program termination should invoke `commonPool().awaitQuiescence`, before exit.

Returns:

the common pool instance

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

End of Key Concurrency & Scheduler Operators in the Flux Class (Part 2)