Applying Key Methods in the Observable Class (Part 2)

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Learning Objectives in this Part of the Lesson

- Recognize key methods in the Observable class & how they are applied in the case studies

Class Observable<T>

java.lang.Object
    io.reactivex.rxjava3.core.Observable<T>

Type Parameters:
    `T` - the type of the items emitted by the `Observable`

All Implemented Interfaces:
    ObservableSource<T>

Direct Known Subclasses:
    ConnectableObservable, GroupedObservable, Subject

```
public abstract class Observable<T>
extends Object
implements ObservableSource<T>
```

The `Observable` class is the non-backpressured, optionally multi-valued base reactive class that offers factory methods, intermediate operators and the ability to consume synchronous and/or asynchronous reactive dataflows.

See reactivex.io/RxJava/3.x/javadoc/io/reactivex/rxjava3/core/Observable.html

Learning Objectives in this Part of the Lesson

- Case study ex2 shows how to apply various RxJava operations *asynchronously* to determine if randomly-generated BigInteger objects are prime or not
  - e.g., create(), interval(), map(), filter(), doOnNext(), take(), doOnComplete(), subscribe(), subscribeOn(), observeOn(), range(), ignoreElements(), count(), & various thread pools

```
Observable
   .create(ObservableEx::emitInterval)
   .map(bi ->
        ObservableEx.checkIfPrime
          (bi, sb))
   .doOnNext(bi -> ObservableEx
            .processResult(bi,
                           sb))
   .doOnComplete(() ->
                 BigFractionUtils
                 .display
                    (sb.toString()))
   .count()
   .ignoreElement();
```

See github.com/douglascraigschmidt/LiveLessons/tree/master/Reactive/Observable/ex2

Applying Key Methods in the Observable Class to ex2

Applying Key Methods in the Observable Class to ex2

- testIsPrimeTimed()
  - Use an asynchronous time-driven Observable stream that processes random BigInteger objects to determine which ones are prime

```
Observable
    .create(ObservableEx::emitInterval)
    .map(bi ->
         ObservableEx.checkIfPrime
           (bi, sb))
    .doOnNext(bi -> ObservableEx
              .processResult(bi,
                             sb))
    .doOnComplete(() ->
                  BigFractionUtils
                  .display
                     (sb.toString()))
    .count()
    .ignoreElement();
```

See Reactive/Observable/ex2/src/main/java/ObservableEx.java

Applying Key Methods in the Observable Class to ex2

- testIsPrimeTimed()
  - Use an asynchronous time-driven Observable stream that processes random BigInteger objects to determine which ones are prime
  - Demonstrates create(), interval(), map(), filter(), doOnNext(), take(), doOnComplete(), subscribe(), & the Schedulers.computation() thread pool

```
Observable
   .create(ObservableEx::emitInterval)
   .map(bi ->
        ObservableEx.checkIfPrime
          (bi, sb))
   .doOnNext(bi -> ObservableEx
             .processResult(bi,
                            sb))
   .doOnComplete(() ->
                 BigFractionUtils
                 .display
                    (sb.toString()))
   .count()
   .ignoreElement();
```

Applying Key Methods in the Observable Class to ex2

- The create() method
  - Create an Observable with the capability of emitting multiple elements in a synchronous or asynchronous manner

```
static <T> Observable<T> create
   (ObservableOnSubscribe<T> source )
```

See reactivex.io/RxJava/3.x/javadoc/io/reactivex/rxjava3/core/Observable.html#create

Applying Key Methods in the Observable Class to ex2

- The create() method
  - Create an Observable with the capability of emitting multiple elements in a synchronous or asynchronous manner
    - The ObservableOnSubscribe param has a subscribe() method that receives an instance of an ObservableEmitter instance

```
static <T> Observable<T> create
  (ObservableOnSubscribe<T> source)
```

See reactivex.io/RxJava/3.x/javadoc/io/reactivex/rxjava3/core/ObservableOnSubscribe.html

Applying Key Methods in the Observable Class to ex2

- The create() method
  - Create an Observable with the capability of emitting multiple elements in a synchronous or asynchronous manner
    - The ObservableOnSubscribe param has a subscribe() method that receives an instance of an ObservableEmitter instance
      - ObservableEmitter can emit events via onNext(), onError(), & onComplete()

```
static <T> Observable<T> create
    (ObservableOnSubscribe<T> source )
```

Interface ObservableEmitter<T>

Type Parameters:

T - the value type to emit

All Superinterfaces:

Emitter<T>

```
public interface ObservableEmitter<T>
extends Emitter<T>
```

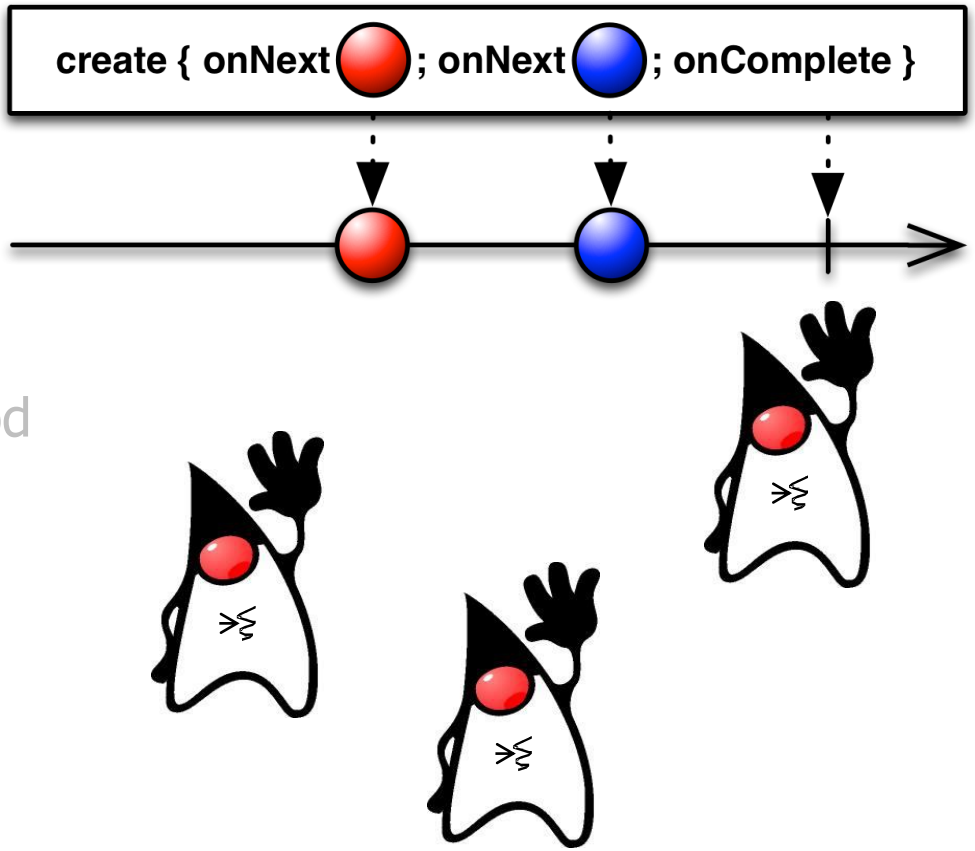
Abstraction over an RxJava `Observer` that allows associating a resource with it.

The `Emitter.onNext(Object)`, `Emitter.onError(Throwable)`, `tryOnError(Throwable)` and `Emitter.onComplete()` methods should be called in a sequential manner, just like the `Observer`'s methods should be. Use the `ObservableEmitter` the `serialize()` method returns instead of the original `ObservableEmitter` instance provided by the generator routine if you want to ensure this. The other methods are thread-safe.

See reactivex.io/RxJava/3.x/javadoc/io/reactivex/rxjava3/core/ObservableEmitter.html

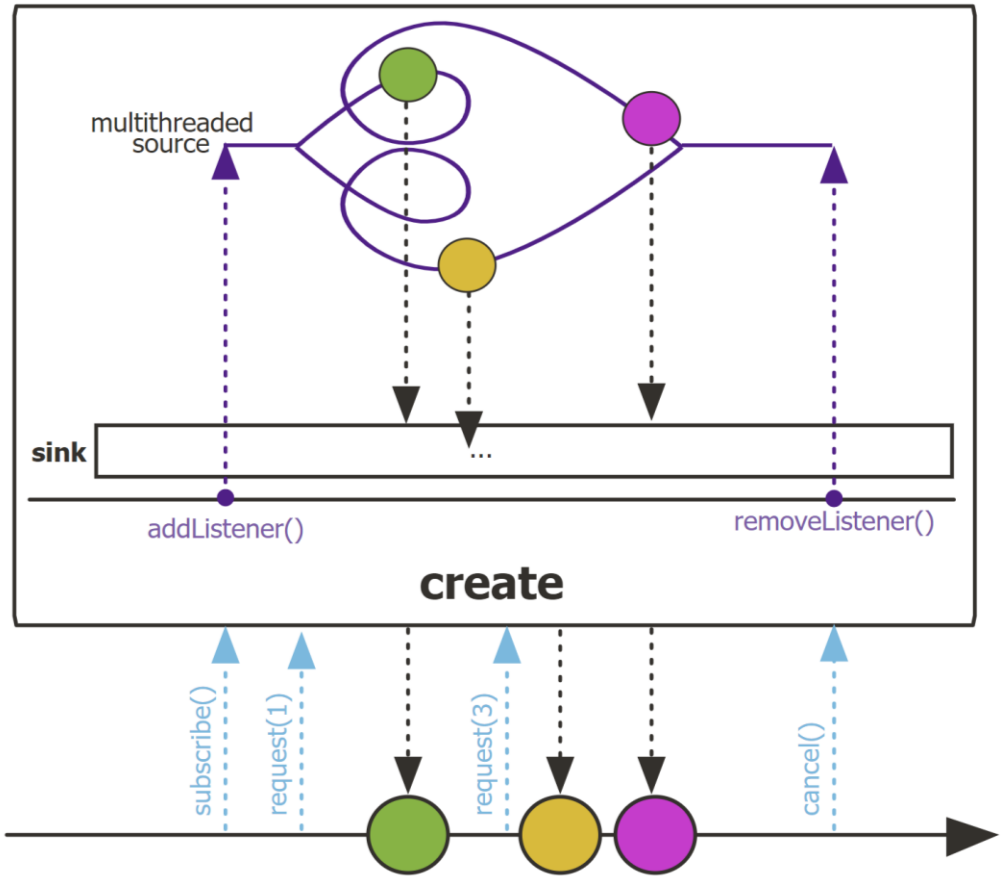
Applying Key Methods in the Observable Class to ex2

- The create() method
  - Create an Observable with the capability of emitting multiple elements in a synchronous or asynchronous manner
    - The ObservableOnSubscribe param has a subscribe() method that receives an instance of an ObservableEmitter instance
    - Elements can be emitted from different threads



Applying Key Methods in the Observable Class to ex2

- The create() method
  - Create an Observable with the capability of emitting multiple elements in a synchronous or asynchronous manner
  - Project Reactor's Flux.create() method works in a similar way
    - Though it is more complex



See projectreactor.io/docs/core/release/api/reactor/core/publisher/Flux.html#create

Applying Key Methods in the Observable Class to ex2

- The create() method
  - Create an Observable with the capability of emitting multiple elements in a synchronous or asynchronous manner
  - Project Reactor's Flux.create() method works in a similar way
  - Also similar to the method Stream.generate() in Java Streams

generate

```
static <T> Stream<T> generate(Supplier<T> s)
```

Returns an infinite sequential unordered stream where each element is generated by the provided `Supplier`. This is suitable for generating constant streams, streams of random elements, etc.

Type Parameters:

`T - the type of stream elements`

Parameters:

`s - the Supplier of generated elements`

Returns:

`a new infinite sequential unordered Stream`

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

Applying Key Methods in the Observable Class to ex2

- The interval() method
  - Create a Observable that emits long values starting with zero

```
static Observable<Long> interval
   (long period, TimeUnit unit)
```

See reactivex.io/RxJava/3.x/javadoc/io/reactivex/rxjava3/core/Observable.html#interval

Applying Key Methods in the Observable Class to ex2

- The interval() method
  - Create a Observable that emits long values starting with zero
    - The value is incremented at the specified time intervals on the global timer

```
static Observable<Long> interval
  (long period, TimeUnit unit)
```

Applying Key Methods in the Observable Class to ex2

- The interval() method
  - Create a Observable that emits long values starting with zero
    - The value is incremented at the specified time intervals on the global timer
    - This method emits long values on Schedulers.computation() method by default

computation

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

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

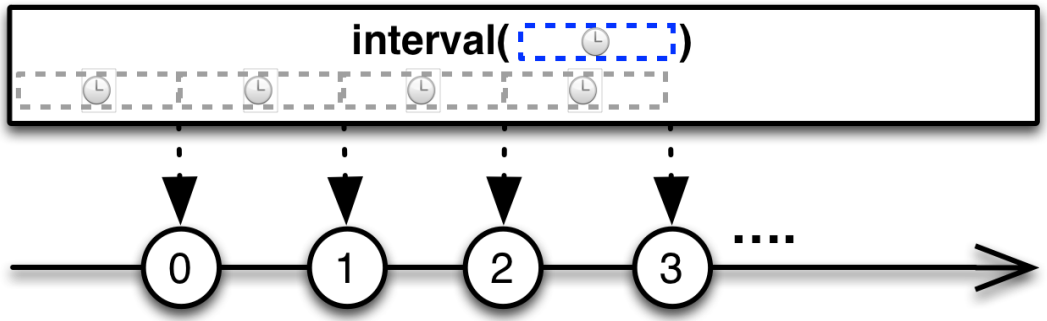
This can be used for event-loops, processing callbacks and other computational work.

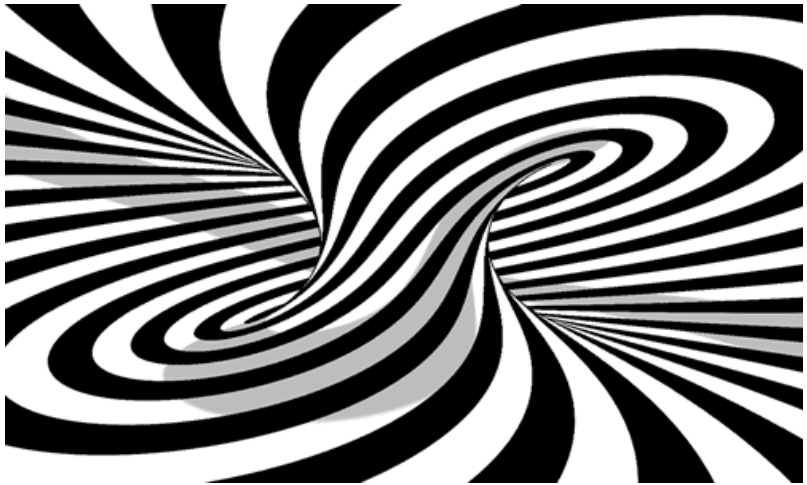
It is not recommended to perform blocking, IO-bound work on this scheduler. Use `io()` instead.

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

Applying Key Methods in the Observable Class to ex2

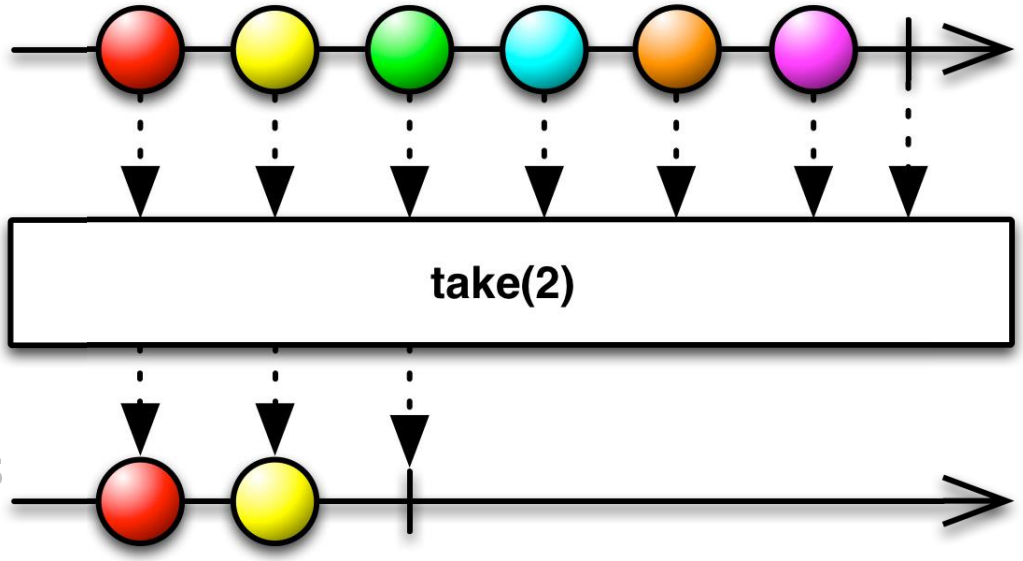
- The interval() method
  - Create a Observable that emits long values starting with zero
    - The value is incremented at the specified time intervals on the global timer
    - This method emits long values on Schedulers.computation() method by default
    - In normal conditions, the Observable never completes





Applying Key Methods in the Observable Class to ex2

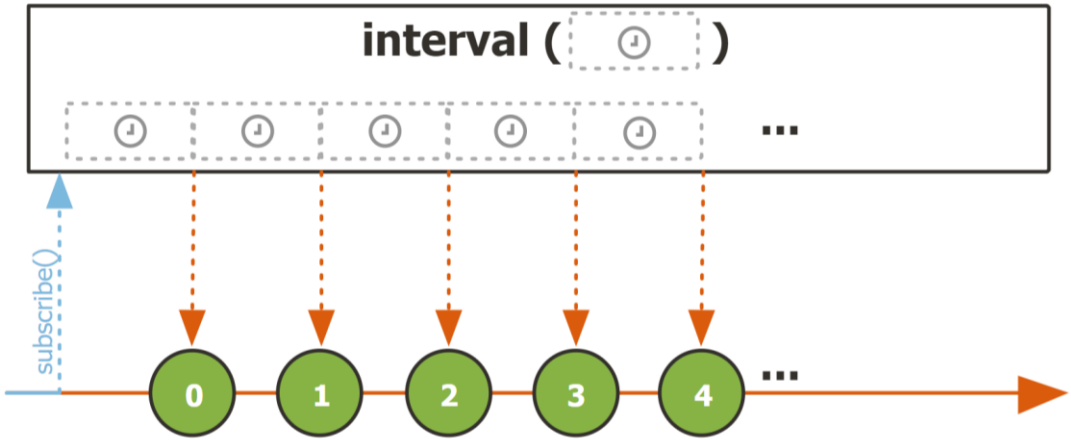
- The interval() method
  - Create a Observable that emits long values starting with zero
    - The value is incremented at the specified time intervals on the global timer
    - This method emits long values on Schedulers.computation() method by default
  - In normal conditions, the Observable never completes
    - It's therefore often used with take()



See upcoming discussion of the Observable.take() method

Applying Key Methods in the Observable Class to ex2

- The interval() method
  - Create a Observable that emits long values starting with zero
  - Project Reactor's Flux.interval() works the same



See projectreactor.io/docs/core/release/api/reactor/core/publisher/Flux.html#interval

Applying Key Methods in the Observable Class to ex2

- The filter() method
  - Evaluate each source value against the given Predicate

```
Observable<T> filter
   (Predicate<? super T> p)
```

See reactivex.io/RxJava/3.x/javadoc/io/reactivex/rxjava3/core/Observable.html#filter

Applying Key Methods in the Observable Class to ex2

- The filter() method
  - Evaluate each source value against the given Predicate
    - If the predicate test succeeds, the value is emitted

```
Observable<T> filter
   (Predicate<? super T> p)
```

Interface Predicate<T>

Type Parameters:

T - the type of the input to the predicate

Functional Interface:

This is a functional interface and can therefore be used as the assignment target for a lambda expression or method reference.

See reactivex.io/RxJava/3.x/javadoc/io/reactivex/rxjava3/functions/Predicate.html

Applying Key Methods in the Observable Class to ex2

- The filter() method
  - Evaluate each source value against the given Predicate
    - If the predicate test succeeds, the value is emitted
    - If the predicate test fails, the value is ignored & a request of 1 is made upstream

```
Observable<T> filter
   (Predicate<? super T> p)
```

Interface Predicate<T>

Type Parameters:

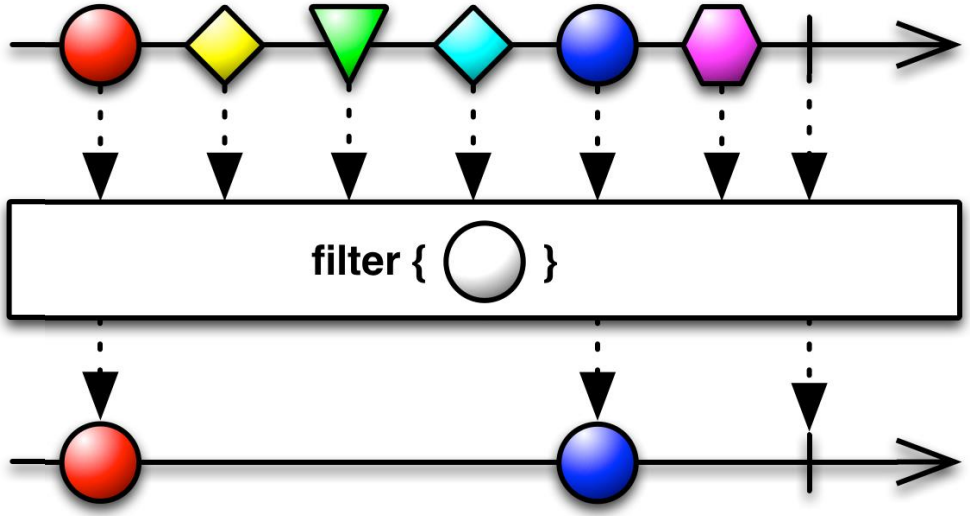
T - the type of the input to the predicate

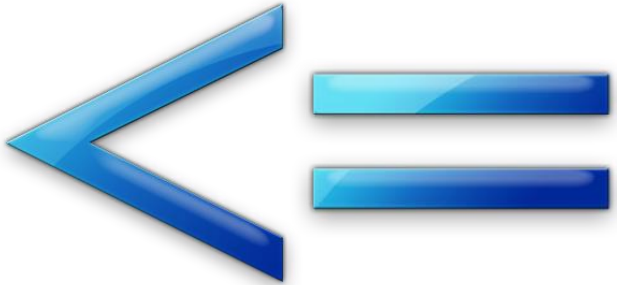
Functional Interface:

This is a functional interface and can therefore be used as the assignment target for a lambda expression or method reference.

Applying Key Methods in the Observable Class to ex2

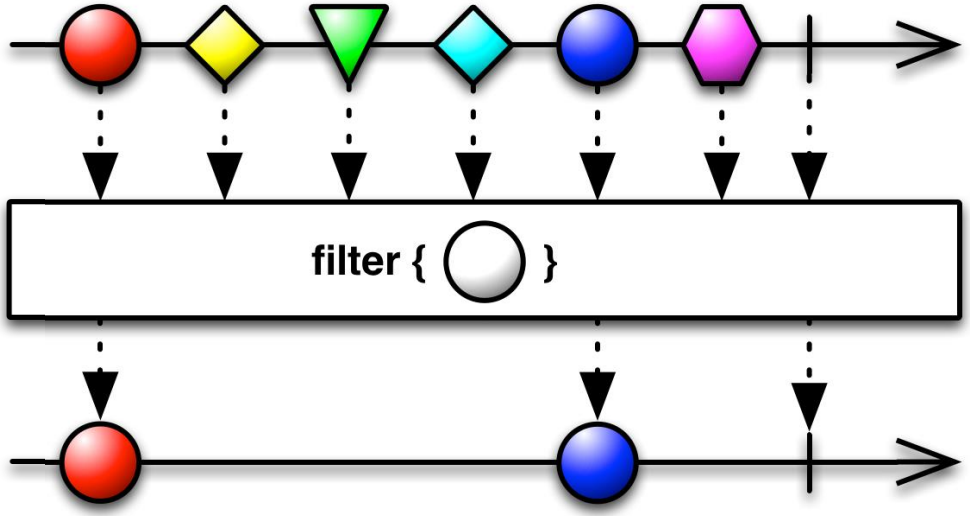
- The filter() method
  - Evaluate each source value against the given Predicate
    - If the predicate test succeeds, the value is emitted
    - If the predicate test fails, the value is ignored & a request of 1 is made upstream
  - The # of output elements may be less than the # of input elements





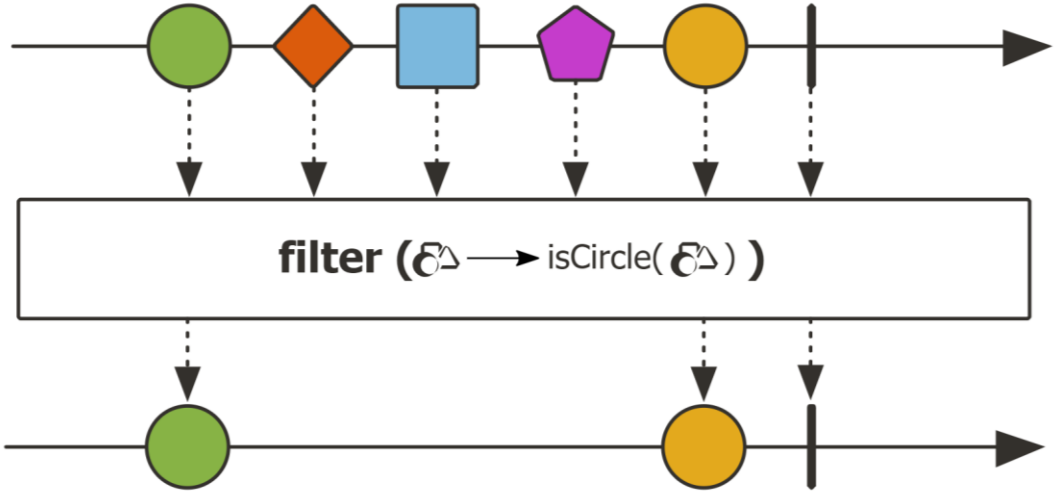
Applying Key Methods in the Observable Class to ex2

- The filter() method
  - Evaluate each source value against the given Predicate
    - If the predicate test succeeds, the value is emitted
    - If the predicate test fails, the value is ignored & a request of 1 is made upstream
    - The # of output elements may be less than the # of input elements
    - filter() can't change the type or value of elements it processes



Applying Key Methods in the Observable Class to ex2

- The filter() method
  - Evaluate each source value against the given Predicate
  - Project Reactor's Flux.filter() method works the same



See projectreactor.io/docs/core/release/api/reactor/core/publisher/Flux.html#filter

Applying Key Methods in the Observable Class to ex2

- The filter() method
  - Evaluate each source value against the given Predicate
  - Project Reactor's Flux.filter() method works the same
  - Similar to Stream.filter() method in Java Streams

filter

```
Stream<T> filter(Predicate<? super T> predicate)
```

Returns a stream consisting of the elements of this stream that match the given predicate.

This is an intermediate operation.

Parameters:

predicate - a non-interfering, stateless predicate to apply to each element to determine if it should be included

Returns:

the new stream

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

Applying Key Methods in the Observable Class to ex2

- The doOnNext() method
  - Add a behavior

```
Observable<T> doOnNext
  (Consumer<? super T> onNext)
```

See reactivex.io/RxJava/3.x/javadoc/io/reactivex/rxjava3/core/Observable.html#doOnNext

Applying Key Methods in the Observable Class to ex2

- The doOnNext() method
  - Add a behavior
    - This behavior is triggered when the Observable emits an item

```
Observable<T> doOnNext
  (Consumer<? super T> onNext)
```

Interface Consumer<T>

Type Parameters:

T - the type of the input to the operation

All Known Subinterfaces:

Stream.Builder<T>

Functional Interface:

This is a functional interface and can therefore be used as the assignment target for a lambda expression or method reference.

See reactivex.io/RxJava/3.x/javadoc/io/reactivex/rxjava3/functions/Consumer.html

Applying Key Methods in the Observable Class to ex2

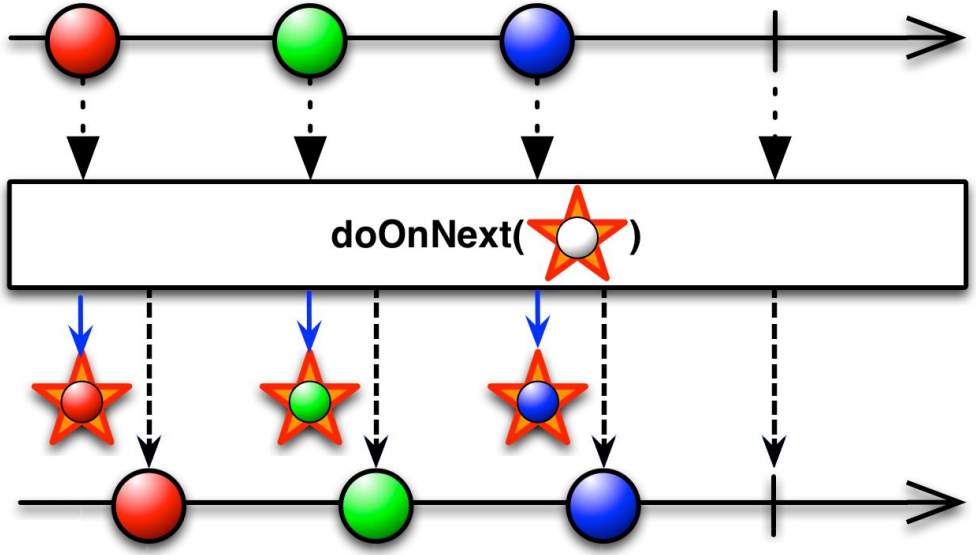
- The doOnNext() method
  - Add a behavior
    - This behavior is triggered when the Observable emits an item
      - i.e., it is a "callback"

```
Observable<T> doOnNext
  (Consumer<? super T> onNext)
```

See en.wikipedia.org/wiki/Callback_(computer_programming)

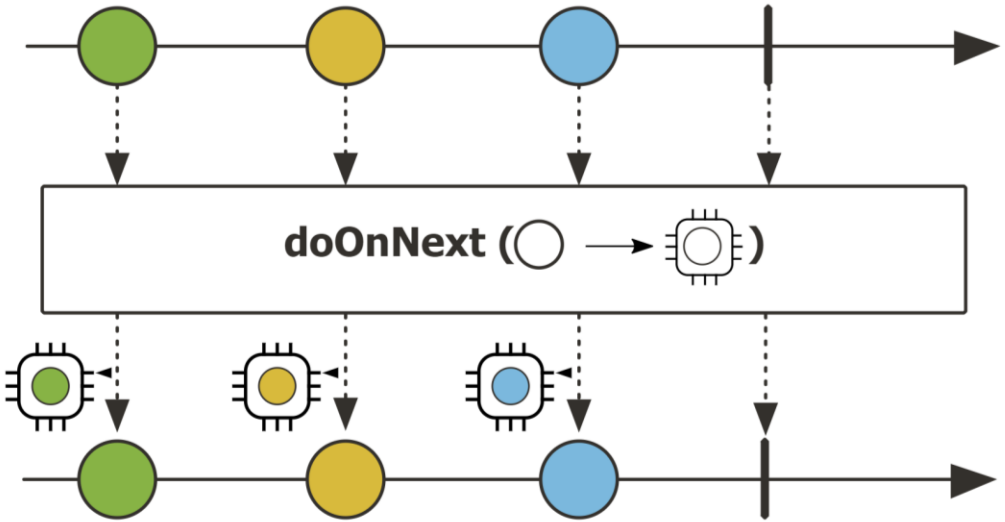
Applying Key Methods in the Observable Class to ex2

- The doOnNext() method
  - Add a behavior
  - Can't change the type or value of elements it processes



Applying Key Methods in the Observable Class to ex2

- The doOnNext() method
  - Add a behavior
  - Project Reactor's method Flux .doOnNext() works the same



See projectreactor.io/docs/core/release/api/reactor/core/publisher/Flux.html#doOnNext

Applying Key Methods in the Observable Class to ex2

- The doOnNext() method
  - Add a behavior
  - Project Reactor's method Flux .doOnNext() works the same
  - Similar to Stream.peek() method in Java Streams

peek

`Stream<T> peek(Consumer<? super T> action)`

Returns a stream consisting of the elements of this stream, additionally performing the provided action on each element as elements are consumed from the resulting stream.

This is an intermediate operation.

For parallel stream pipelines, the action may be called at whatever time and in whatever thread the element is made available by the upstream operation. If the action modifies shared state, it is responsible for providing the required synchronization.

API Note:

This method exists mainly to support debugging, where you want to see the elements as they flow past a certain point in a pipeline:

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

Applying Key Methods in the Observable Class to ex2

- The take() method

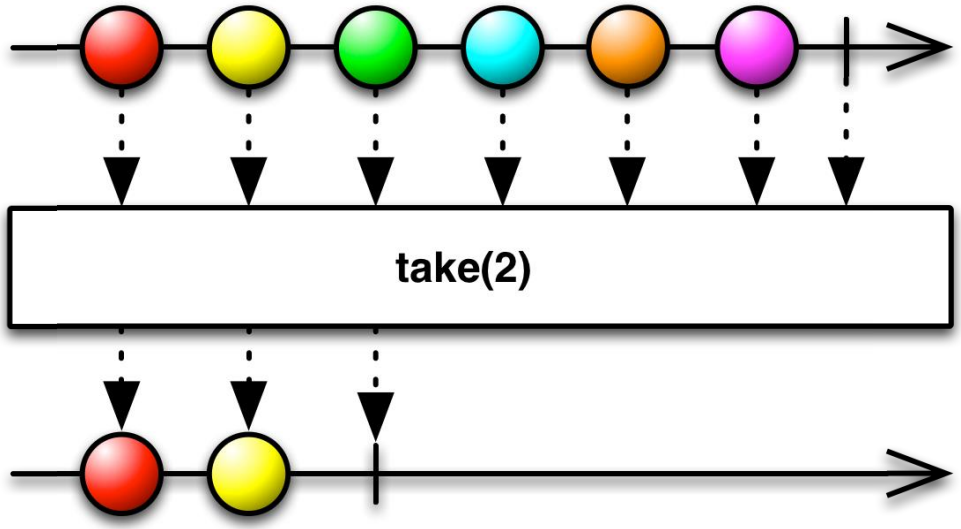
```
Observable<T> take(long n)
```

  - Take only the first N values from this Observable, if available

See reactivex.io/RxJava/3.x/javadoc/io/reactivex/rxjava3/core/Observable.html#take

Applying Key Methods in the Observable Class to ex2

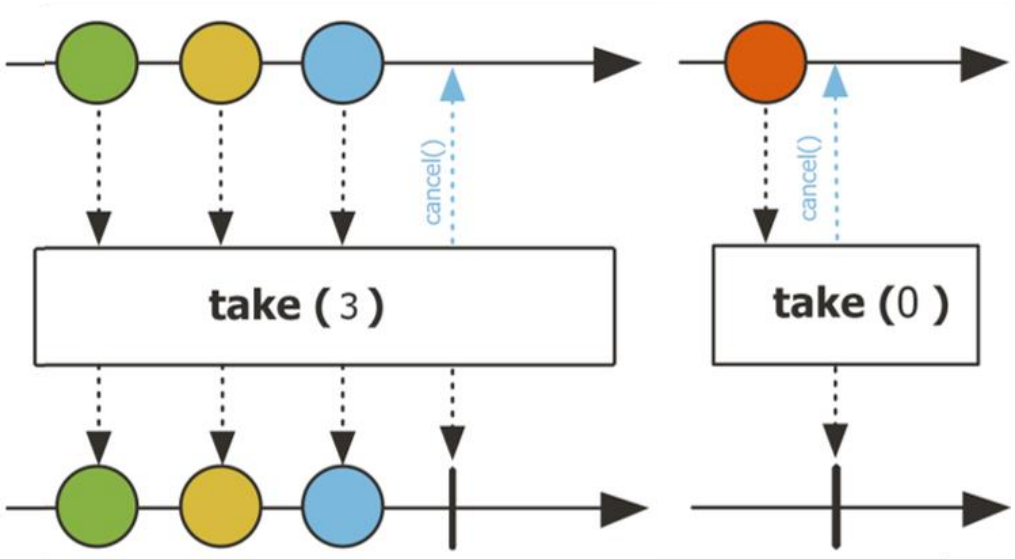
- The take() method
  - Take only the first N values from this Observable, if available
  - Used to limit otherwise "infinite" streams



See earlier discussion of the Observable.interval() method

Applying Key Methods in the Observable Class to ex2

- The take() method
  - Take only the first N values from this Observable, if available
  - Used to limit otherwise "infinite" streams
  - Project Reactor's Flux.take() method works the same



See projectreactor.io/docs/core/release/api/reactor/core/publisher/Flux.html#take

Applying Key Methods in the Observable Class to ex2

- The take() method
  - Take only the first N values from this Observable, if available
  - Used to limit otherwise "infinite" streams
  - Project Reactor's Flux.take() method works the same
  - Similar to Stream.limit() in Java Streams

limit

`Stream<T> limit(long maxSize)`

Returns a stream consisting of the elements of this stream, truncated to be no longer than `maxSize` in length.

This is a short-circuiting stateful intermediate operation.

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

Applying Key Methods in the Observable Class to ex2

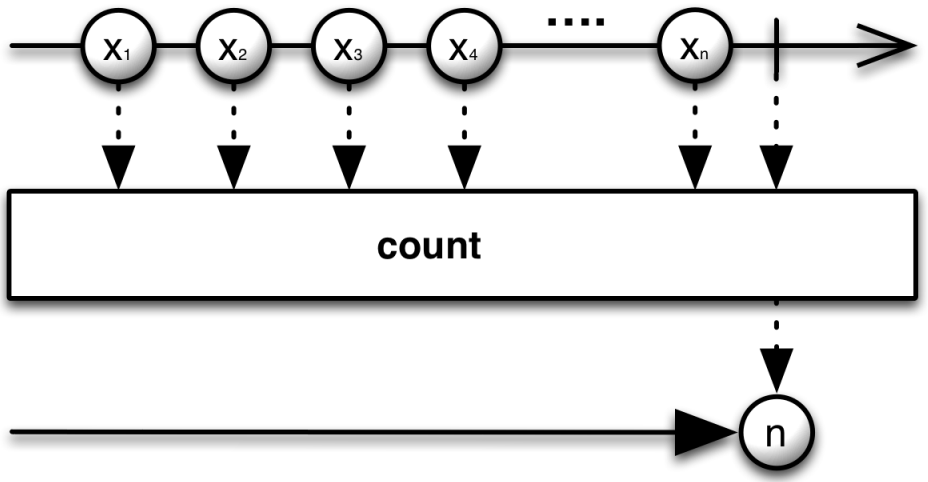
- The count() method
  - Returns a Single that counts the total # of items emitted by the current Observable & emits this count as a 64-bit Long

```
Single<Long> count()
```

See reactivex.io/RxJava/3.x/javadoc/io/reactivex/rxjava3/core/Observable.html#count

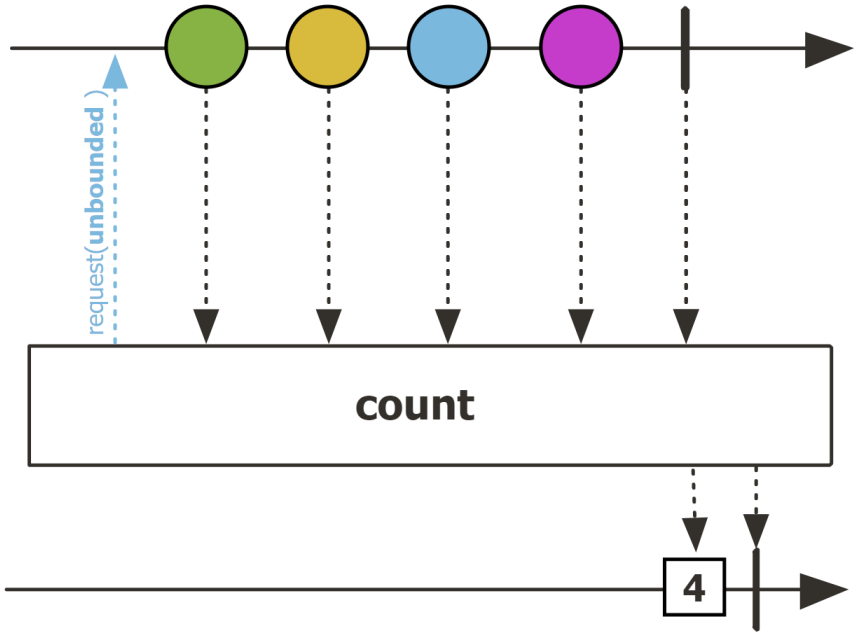
Applying Key Methods in the Observable Class to ex2

- The count() method
  - Returns a Single that counts the total # of items emitted by the current Observable & emits this count as a 64-bit Long
    - count() doesn't operate on a particular Scheduler by default



Applying Key Methods in the Observable Class to ex2

- The count() method
  - Returns a Single that counts the total # of items emitted by the current Observable & emits this count as a 64-bit Long
  - Project Reactor's Flux.count() method works the same



See projectreactor.io/docs/core/release/api/reactor/core/publisher/Flux.html#count

Applying Key Methods in the Observable Class to ex2

- The count() method
  - Returns a Single that counts the total # of items emitted by the current Observable & emits this count as a 64-bit Long
  - Project Reactor's Flux.count() method works the same
  - Similar to the Stream.count() method in Java Streams

count

```
long count()
```

Returns the count of elements in this stream. This is a special case of a reduction and is equivalent to:

```
return mapToLong(e -> 1L).sum();
```

This is a terminal operation.

Returns:

the count of elements in this stream

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

Applying Key Methods in the Observable Class to ex2

- The subscribe() method
  - Subscribe a Consumer to this Observable

```
Disposable subscribe
   (Consumer<? super T> consumer,
    Consumer<? super Throwable>
      errorConsumer,
    Runnable completeConsumer)
```

See reactivex.io/RxJava/3.x/javadoc/io/reactivex/rxjava3/core/Observable.html#subscribe

Applying Key Methods in the Observable Class to ex2

- The subscribe() method
  - Subscribe a Consumer to this Observable
    - This method consumes all elements in the sequence, handles errors, & reacts to completion

```
Disposable subscribe
   (Consumer<? super T> consumer,
    Consumer<? super Throwable>
      errorConsumer,
    Runnable completeConsumer)
```

Interface Consumer<T>

Type Parameters:

T - the type of the input to the operation

All Known Subinterfaces:

Stream.Builder<T>

Functional Interface:

This is a functional interface and can therefore be used as the assignment target for a lambda expression or method reference.

See reactivex.io/RxJava/3.x/javadoc/io/reactivex/rxjava3/functions/Consumer.html

Applying Key Methods in the Observable Class to ex2

- The subscribe() method
  - Subscribe a Consumer to this Observable
    - This method consumes all elements in the sequence, handles errors, & reacts to completion
      - This subscription requests unbounded demand
        - i.e., Long.MAX_VALUE

```
Disposable subscribe
   (Consumer<? super T> consumer,
    Consumer<? super Throwable>
      errorConsumer,
    Runnable completeConsumer)
```

Applying Key Methods in the Observable Class to ex2

- The subscribe() method
  - Subscribe a Consumer to this Observable
    - This method consumes all elements in the sequence, handles errors, & reacts to completion
      - This subscription requests unbounded demand
    - Signals emitted to this method are represented by the following regular expression:

      `onNext()*(onComplete()|onError())?`

subscribe

```
@CheckReturnValue
 @SchedulerSupport(value="none")
 @NonNull
public final @NonNull Disposable subscribe(@NonNull @NonNull Consumer<? super T> onNext,
        @NonNull @NonNull Consumer<? super Throwable> onError,
        @NonNull @NonNull Action onComplete)
```

Subscribes to the current `Observable` and provides callbacks to handle the items it emits and any error or completion notification it signals.

Scheduler:

`subscribe` does not operate by default on a particular `Scheduler`.

Parameters:

`onNext` - the `Consumer<T>` you have designed to accept emissions from the current `Observable`

`onError` - the `Consumer<Throwable>` you have designed to accept any error notification from the current `Observable`

`onComplete` - the `Action` you have designed to accept a completion notification from the current `Observable`

Returns:

the new `Disposable` instance that can be used to dispose the subscription at any time

Applying Key Methods in the Observable Class to ex2

- The subscribe() method
  - Subscribe a Consumer to this Observable
    - This method consumes all elements in the sequence, handles errors, & reacts to completion
    - A Disposable is returned, which indicates a task or resource that can be cancelled/disposed

```
Disposable subscribe
   (Consumer<? super T> consumer,
    Consumer<? super Throwable>
      errorConsumer,
    Runnable completeConsumer)
```

See reactivex.io/RxJava/3.x/javadoc/io/reactivex/rxjava3/disposables/Disposable.html

Applying Key Methods in the Observable Class to ex2

- The subscribe() method
  - Subscribe a Consumer to this Observable
    - This method consumes all elements in the sequence, handles errors, & reacts to completion
    - A Disposable is returned, which indicates a task or resource that can be cancelled/disposed
      - Disposables can be accumulated & disposed in one fell swoop!

```
CompositeDisposable
  mDisposables
    (mPublisherScheduler,
     mSubscriberScheduler,
     mSubscriber);

...

mDisposables.dispose();
```

See reactivex.io/RxJava/3.x/javadoc/io/reactivex/rxjava3/disposables/CompositeDisposable.html

Applying Key Methods in the Observable Class to ex2

- The subscribe() method
  - Subscribe a Consumer to this Observable
  - Calling this method will *not* block the caller thread until the upstream terminates normally or with an error

Applying Key Methods in the Observable Class to ex2

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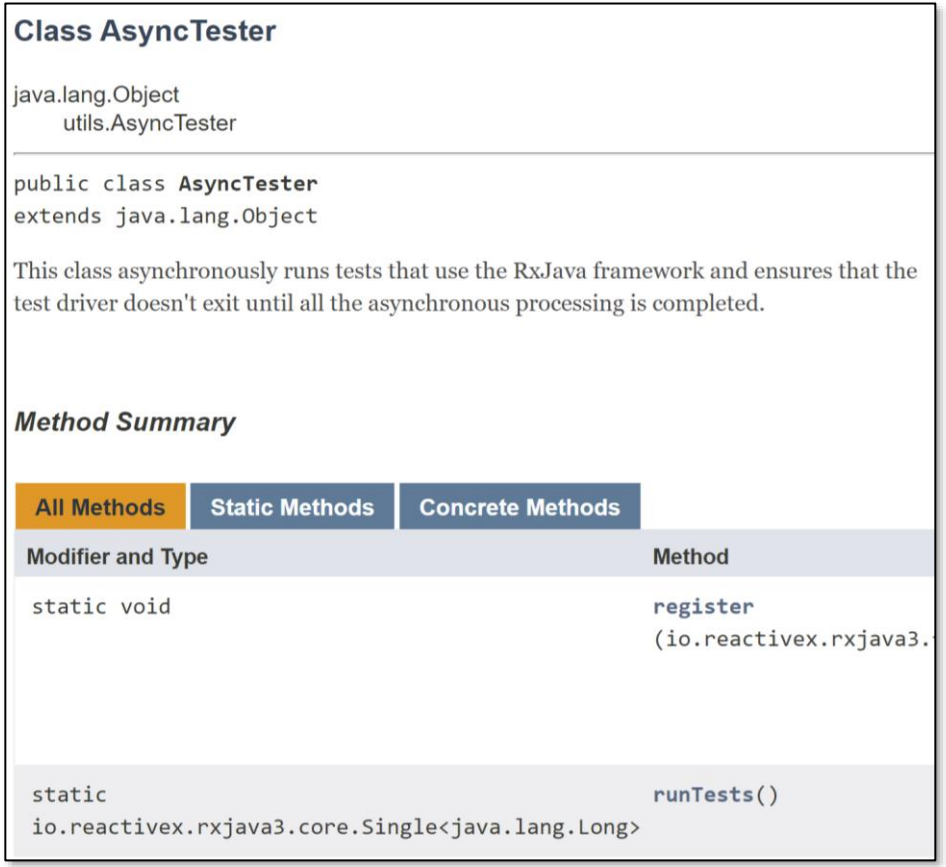
    - These semantics motivate the need for the AsyncTester framework!



Class AsyncTester

java.lang.Object
utils.AsyncTester

```
public class AsyncTester
extends java.lang.Object
```

This class asynchronously runs tests that use the RxJava framework and ensures that the test driver doesn't exit until all the asynchronous processing is completed.

Method Summary

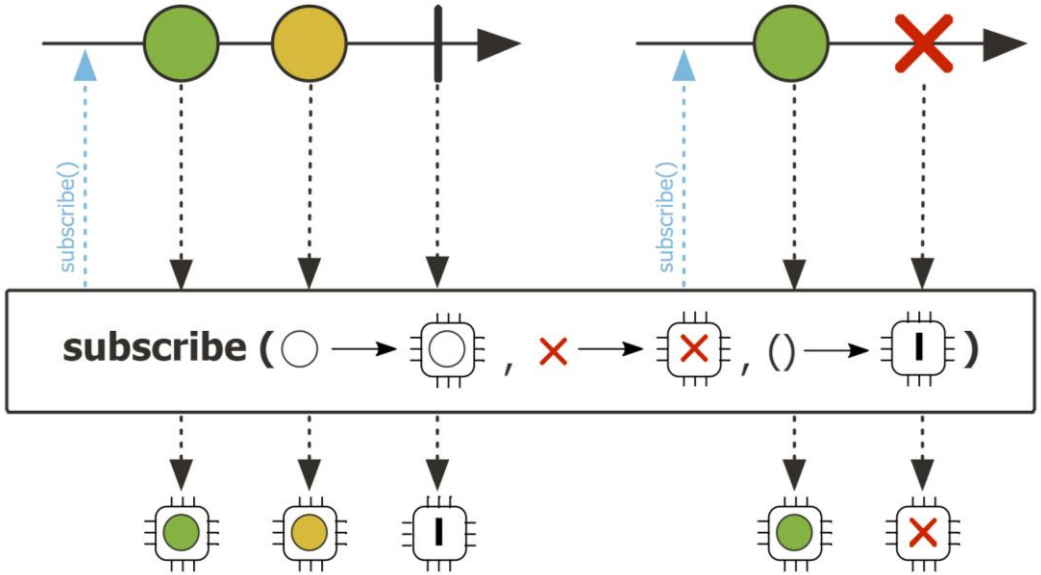
All Methods | Static Methods | Concrete Methods

Modifier and Type	Method
static void	register (io.reactivex.rxjava3.
static io.reactivex.rxjava3.core.Single<java.lang.Long>	runTests()

See Reactive/Observable/ex2/src/main/java/utils/AsyncTester.java

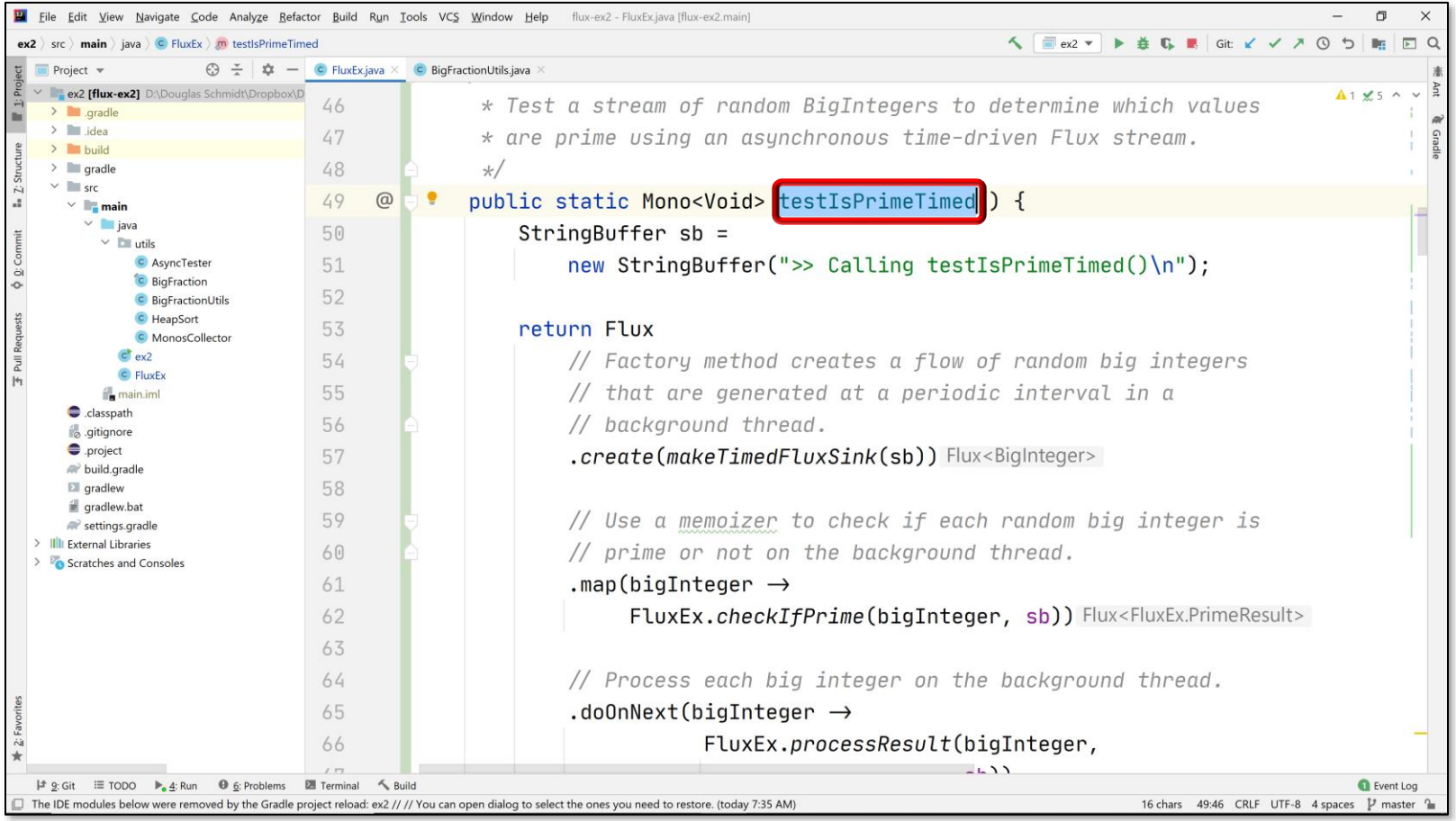
Applying Key Methods in the Observable Class to ex2

- The subscribe() method
  - Subscribe a Consumer to this Observable
  - Calling this method will *not* block the caller thread until the upstream terminates normally or with an error
  - Project Reactor's method Flux .subscribe() works the same



See projectreactor.io/docs/core/release/api/reactor/core/publisher/Flux.html#subscribe

Applying Key Methods in the Observable Class to ex2



See github.com/douglascraigschmidt/LiveLessons/tree/master/Reactive/Observable/ex2

End of Applying Key Methods in the Observable Class (Part 2)