Applying Key Methods in the Observable Class (Part 1)

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

- 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 ex1 shows how to apply various RxJava operations *synchronously* to reduce & multiply BigFraction objects
  - e.g., fromCallable(), repeat(), just(), map(), mergeWith() & subscribe()

```
Observable
   .just(BigFraction.valueOf(100,3),
         BigFraction.valueOf(100,4),
         BigFraction.valueOf(100,2),
         BigFraction.valueOf(100,1))
   .map(fraction -> fraction
      .multiply(sBigReducedFraction))
   .subscribe
      (fraction -> sb.append(" = "
         + fraction.toMixedString()
         + "\n"),
       error -> sb.append("error"),
      () -> BigFractionUtils
        .display(sb.toString()));
```

See github.com/douglascraigschmidt/LiveLessons/tree/master/Reactive/Observable/ex1

Applying Key Methods in the Observable Class to ex1

Applying Key Methods in the Observable Class to ex1

- testFractionMultiplication1()
  - Performs BigFraction reduction & multiplication using a synchronous Observable stream

```
Observable
   .just(BigFraction.valueOf(100,3),
         BigFraction.valueOf(100,4),
         BigFraction.valueOf(100,2),
         BigFraction.valueOf(100,1))

   .map(fraction -> fraction
      .multiply(sBigReducedFrac))

   .blockingSubscribe
      (fraction -> sb.append(" = "
         + fraction.toMixedString()
         + "\n"),
       error -> sb.append("error"),
      () -> BigFractionUtils
        .display(sb.toString()));
```

See Reactive/Observable/ex1/src/main/java/ObservableEx.java

Applying Key Methods in the Observable Class to ex1

- testFractionMultiplication1()
  - Performs BigFraction reduction & multiplication using a synchronous Observable stream
  - Demonstrates the just(), map(), & blockingSubscribe() methods

```
Observable
   .just(BigFraction.valueOf(100,3),
         BigFraction.valueOf(100,4),
         BigFraction.valueOf(100,2),
         BigFraction.valueOf(100,1))

   .map(fraction -> fraction
      .multiply(sBigReducedFrac))

   .blockingSubscribe
      (fraction -> sb.append(" = "
         + fraction.toMixedString()
         + "\n"),
       error -> sb.append("error"),
      () -> BigFractionUtils
        .display(sb.toString()));
```

Applying Key Methods in the Observable Class to ex1

- The just() method
  - Create a Observable that emits the given element(s) & then completes

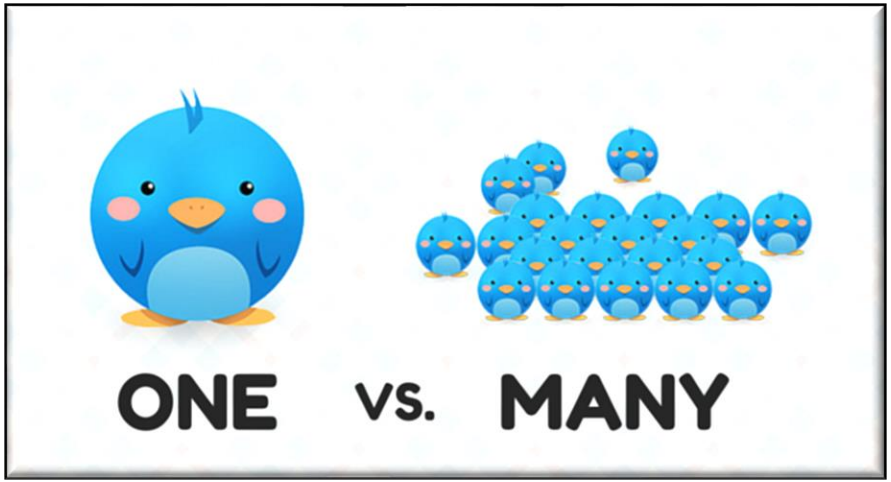
```
static <T> Observable<T> just
                         (T... data)
```

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

Applying Key Methods in the Observable Class to ex1

- The just() method
  - Create a Observable that emits the given element(s) & then completes
    - Multiple elements can be emitted, unlike the Single.just() method

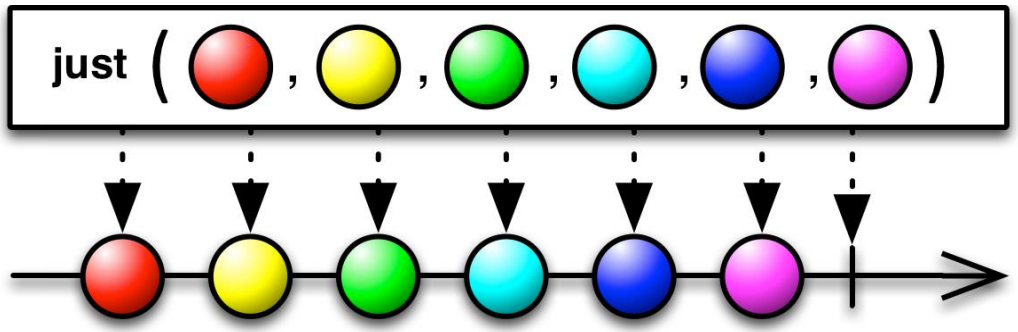
```
static <T> Observable<T> just
                (T... data)
```



See reactivex.io/RxJava/3.x/javadoc/io/reactivex/rxjava3/core/Single.html#just

Applying Key Methods in the Observable Class to ex1

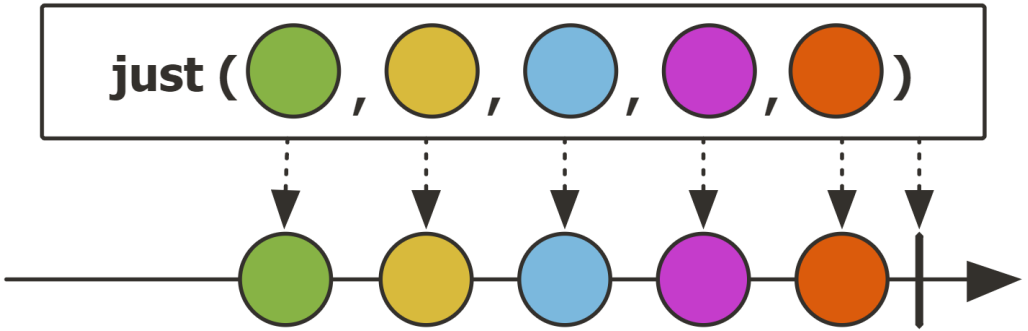
- The just() method
  - Create a Observable that emits the given element(s) & then completes
  - This factory method adapts non-reactive input sources into the reactive model




```
Observable
   .just(BigFraction.valueOf(100,3),
         BigFraction.valueOf(100,4),
         BigFraction.valueOf(100,2),
         BigFraction.valueOf(100,1))
   ...
```

Applying Key Methods in the Observable Class to ex1

- The just() method
  - Create a Observable that emits the given element(s) & then completes
  - This factory method adapts non-reactive input sources into the reactive model
- Project Reactor's Flux.just() method works the same




```
Flux
   .just(BigFraction.valueOf(100,3),
         BigFraction.valueOf(100,4),
         BigFraction.valueOf(100,2),
         BigFraction.valueOf(100,1))
   ...
```

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

Applying Key Methods in the Observable Class to ex1

- The just() method
  - Create a Observable that emits the given element(s) & then completes
  - This factory method adapts non-reactive input sources into the reactive model
  - Project Reactor's Flux.just() method works the same
- Similar to Stream.of() factory method in Java Streams

of

```
@SafeVarargs
static <T> Stream<T> of(T... values)
```

Returns a sequential ordered stream whose elements are the specified values.

Type Parameters:

T - the type of stream elements

Parameters:

values - the elements of the new stream

Returns:

the new stream

```
Stream
   .of(BigFraction.valueOf(100,3),
       BigFraction.valueOf(100,4),
       BigFraction.valueOf(100,2),
       BigFraction.valueOf(100,1))
   ...
```

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

Applying Key Methods in the Observable Class to ex1

- The map() method
  - Transform the item(s) emitted by this Observable

```
<V> Observable<V> map
   (Function<? super T,? extends V>
    mapper)
```

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

Applying Key Methods in the Observable Class to ex1

- The map() method
  - Transform the item(s) emitted by this Observable
    - Applies a synchronous function to transform each item

```
<V> Observable<V> map
  (Function<? super T,? extends V>
   mapper)
```

Interface Function<T,R>

Type Parameters:

T - the type of the input to the function

R - the type of the result of the function

All Known Subinterfaces:

UnaryOperator<T>

Functional Interface:

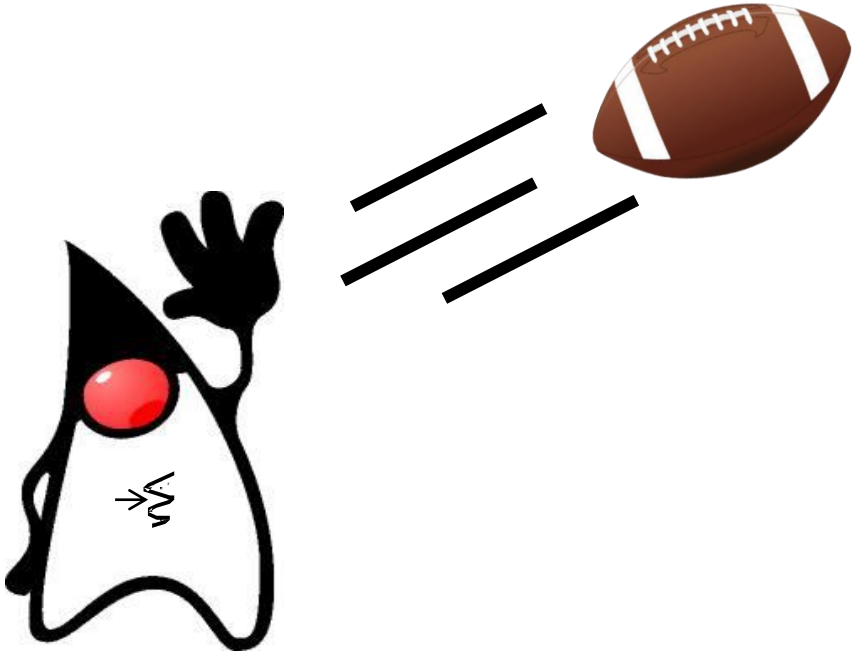
This is a functional interface and can therefore be used as the assignment target for a lambda expression or method reference.

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

Applying Key Methods in the Observable Class to ex1

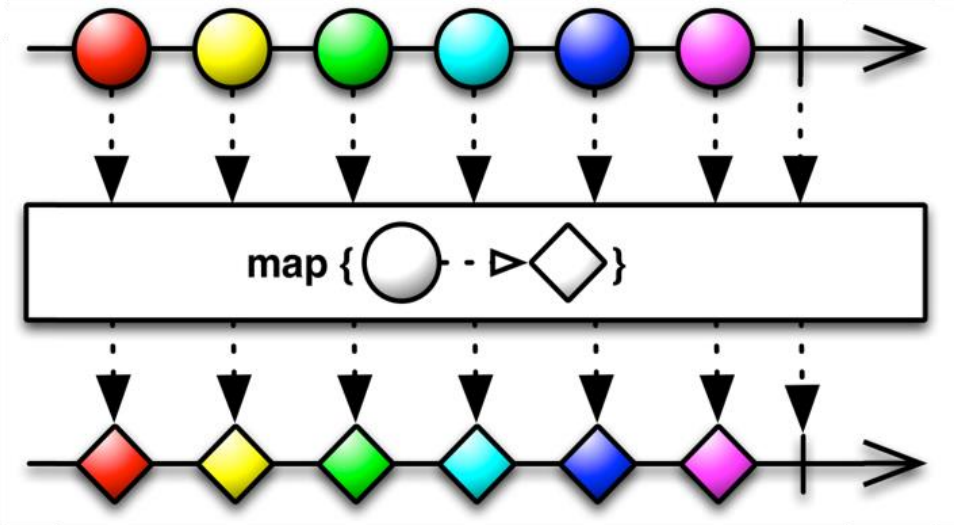
- The map() method
  - Transform the item(s) emitted by this Observable
    - Applies a synchronous function to transform each item
      - map() can terminate if mapper throws an exception

```
<V> Observable<V> map
  (Function<? super T,? extends V>
   mapper)
```



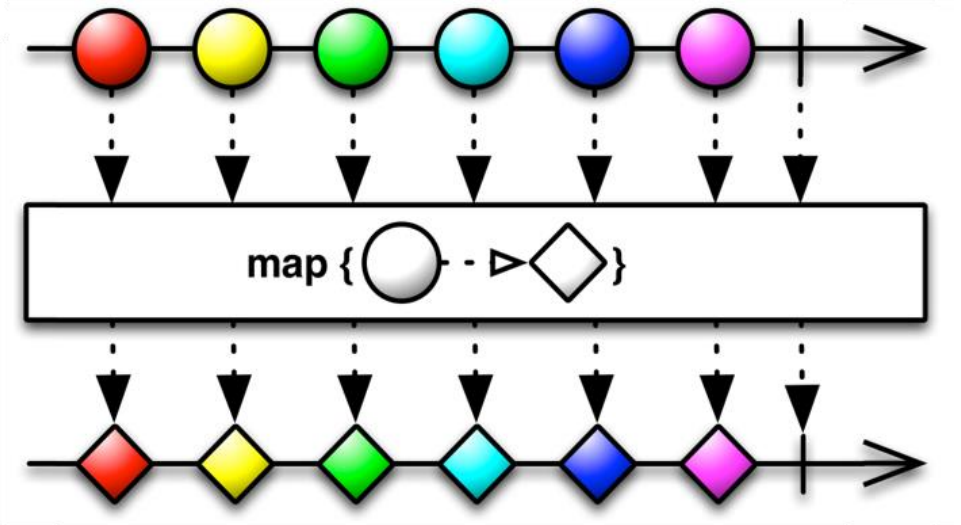
Applying Key Methods in the Observable Class to ex1

- The map() method
  - Transform the item(s) emitted by this Observable
    - Applies a synchronous function to transform each item
    - The # of output items must match the # of input items



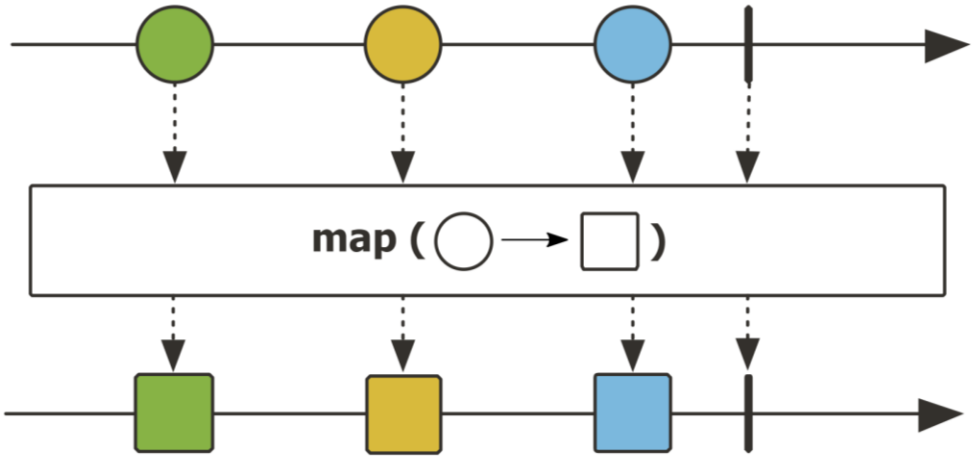
Applying Key Methods in the Observable Class to ex1

- The map() method
  - Transform the item(s) emitted by this Observable
    - Applies a synchronous function to transform each item
    - The # of output items must match the # of input items
    - map() can transform the type of elements it processes



Applying Key Methods in the Observable Class to ex1

- The map() method
  - Transform the item(s) emitted by this Observable
  - Project Reactor's Observable .map() method works the same



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

Applying Key Methods in the Observable Class to ex1

- The map() method
  - Transform the item(s) emitted by this Observable
  - Project Reactor's Observable .map() method works the same
  - Similar to Stream.map() method in Java Streams

map

```
<R> Stream<R> map(Function<? super T,? extends R> mapper)
```

Returns a stream consisting of the results of applying the given function to the elements of this stream.

This is an intermediate operation.

Type Parameters:

`R - The element type of the new stream`

Parameters:

`mapper - a non-interfering, stateless function to apply to each element`

Returns:

`the new stream`

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

Applying Key Methods in the Observable Class to ex1

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

```
void blockingSubscribe
   (Consumer<? super T> consumer,
    Consumer<? super Throwable>
      errorConsumer,
    Runnable completeConsumer)
```

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

Applying Key Methods in the Observable Class to ex1

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

```
void blockingSubscribe
   (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 ex1

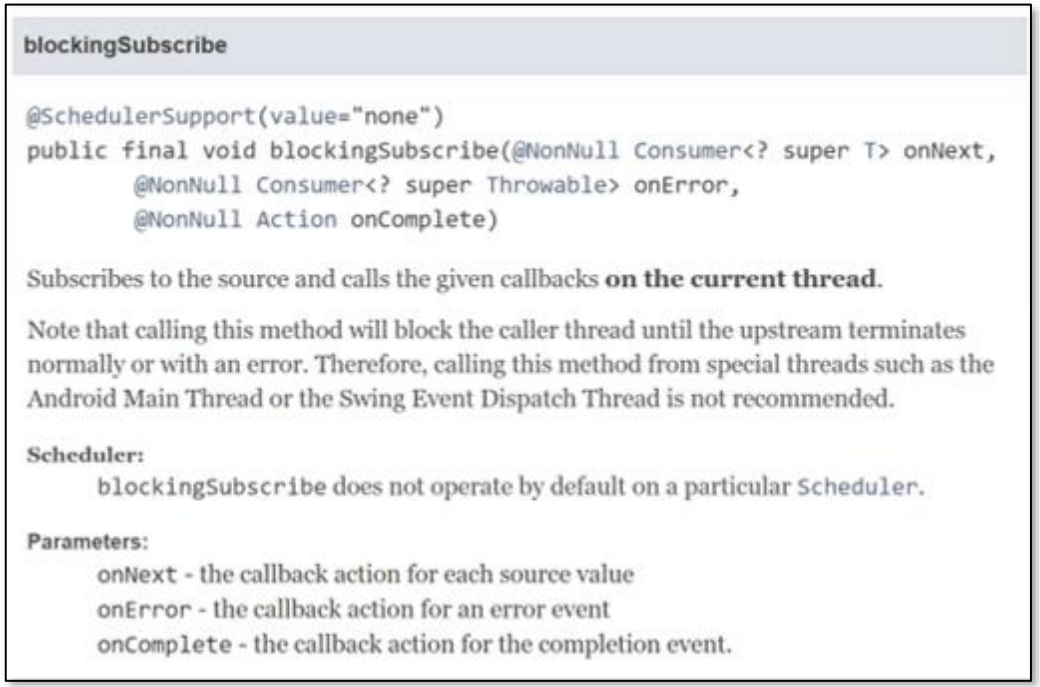
- The blockingSubscribe() method
  - Subscribe a Consumer to this Observable
    - This method consumes all elements in the sequence, handles errors, & reacts to completion
      - This subscription requests "unbounded demand"
        - i.e., Long.MAX_VALUE

```
void blockingSubscribe
   (Consumer<? super T> consumer,
    Consumer<? super Throwable>
      errorConsumer,
    Runnable completeConsumer)
```

Applying Key Methods in the Observable Class to ex1

- The blockingSubscribe() 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())?`



blockingSubscribe

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

Subscribes to the source and calls the given callbacks **on the current thread**.

Note that calling this method will block the caller thread until the upstream terminates normally or with an error. Therefore, calling this method from special threads such as the Android Main Thread or the Swing Event Dispatch Thread is not recommended.

Scheduler:

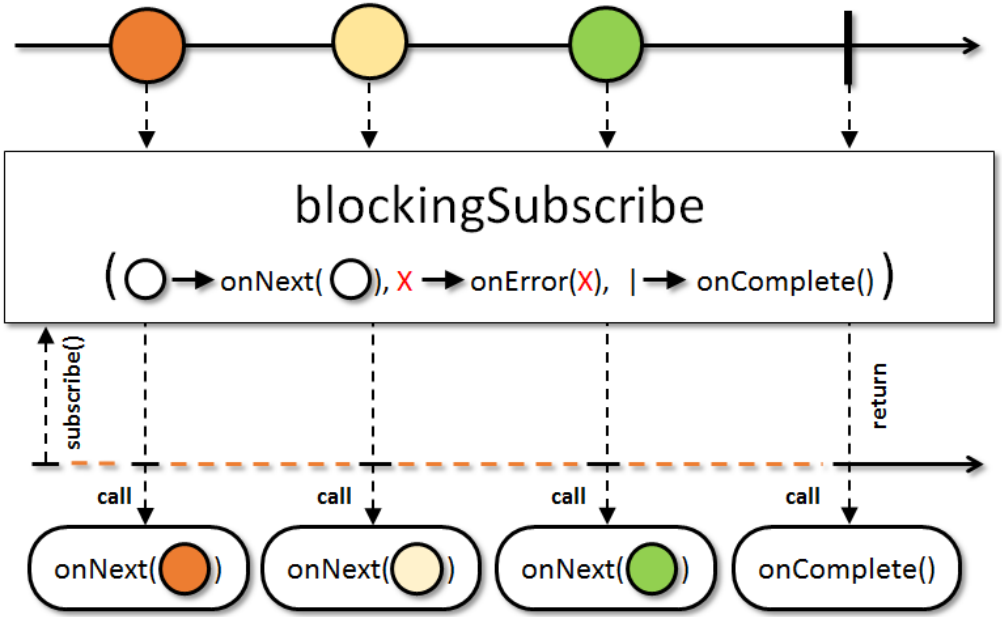
`blockingSubscribe` does not operate by default on a particular `Scheduler`.

Parameters:

`onNext` - the callback action for each source value
`onError` - the callback action for an error event
`onComplete` - the callback action for the completion event.

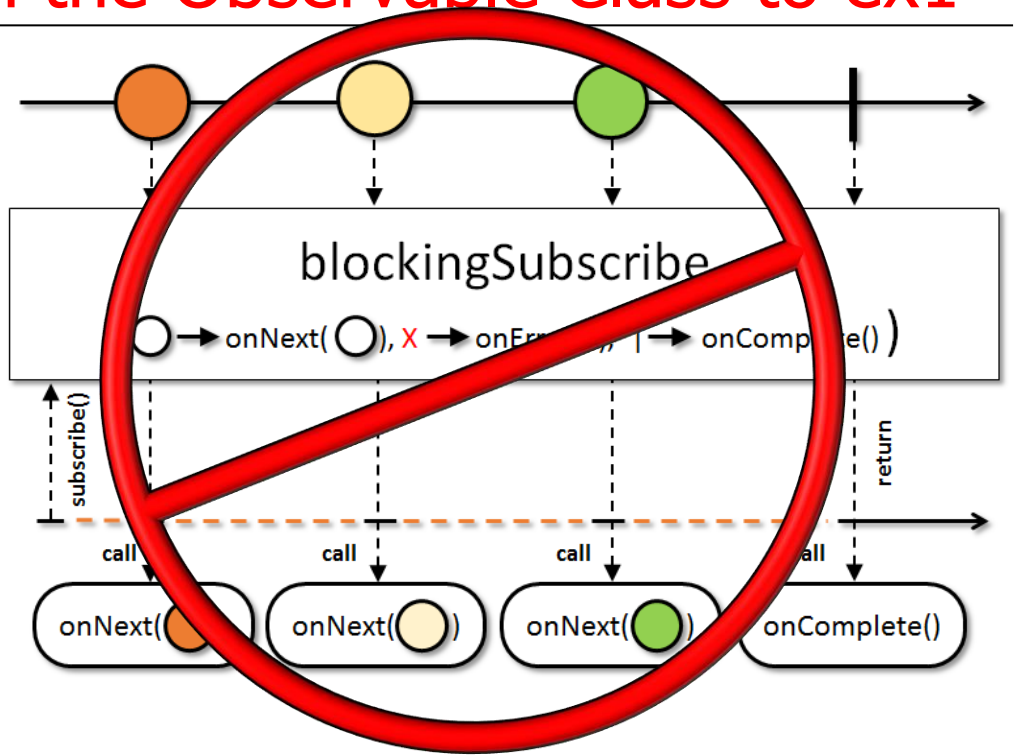
Applying Key Methods in the Observable Class to ex1

- The blockingSubscribe() method
  - Subscribe a Consumer to this Observable
  - Calling this method will block the caller thread until the upstream terminates normally or with an error

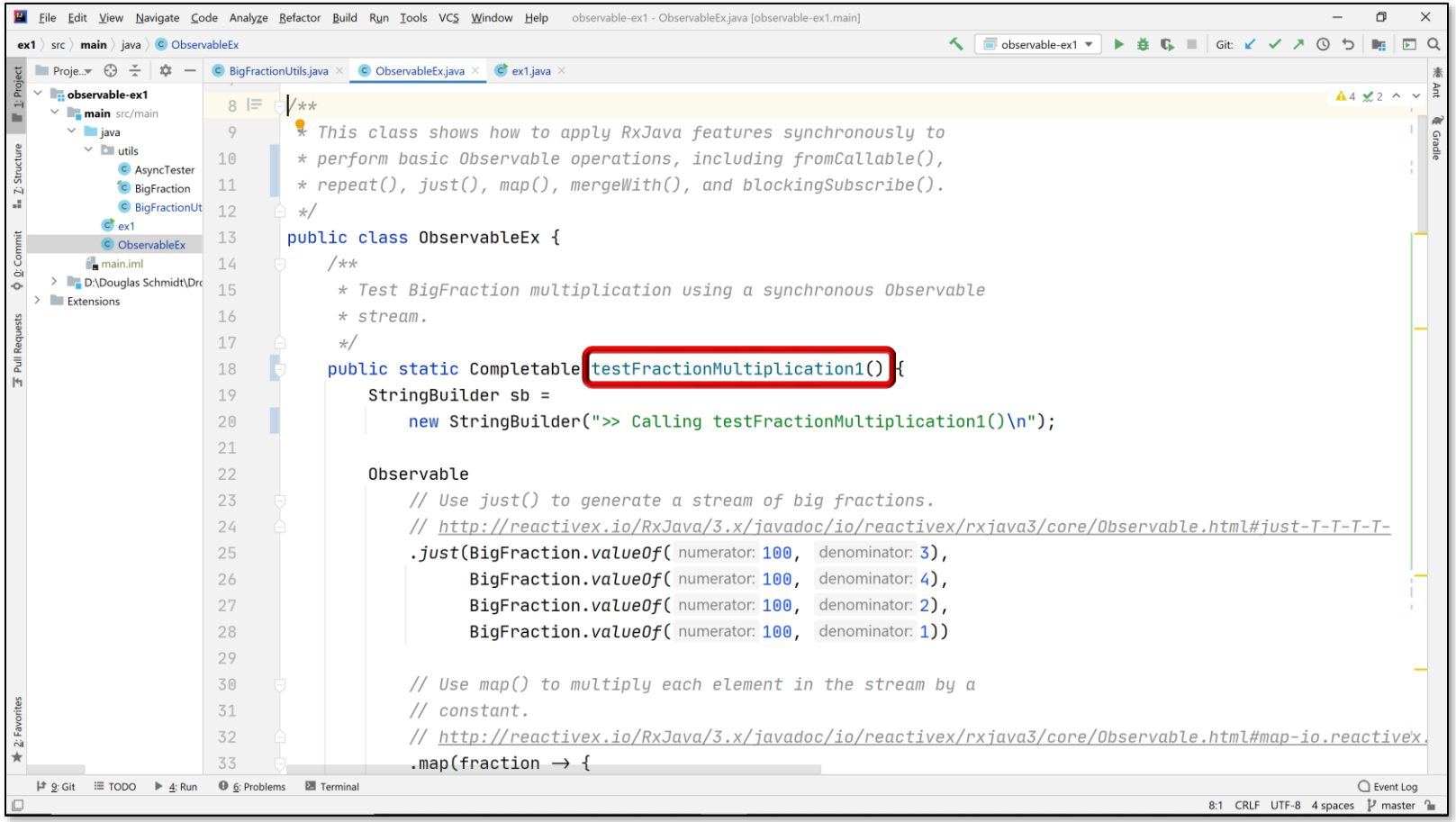


Applying Key Methods in the Observable Class to ex1

- The blockingSubscribe() method
  - Subscribe a Consumer to this Observable
  - Calling this method will block the caller thread until the upstream terminates normally or with an error
  - Oddly, there is no equivalent method in Project Reactor..



Applying Key Methods in the Observable Class to ex1



See github.com/douglascraigschmidt/LiveLessons/tree/master/Reactive/Observable/ex1

Applying Key Methods in the Observable Class to ex1

- testFractionMultiplication2()
  - Performs BigFraction reduction & multiplication using two synchronous Observable streams that are merged together

```
Observable<BigFraction> o1 =
Observable
   .just(BigFraction.valueOf(100, 3),
         BigFraction.valueOf(100, 4),
         BigFraction.valueOf(100, 2),
        BigFraction.valueOf(100, 1));
Observable<BigFraction> o2 =
Observable
     .fromCallable(() ->
         BigFractionUtils.
             makeBigFraction
               (random, true))
     .repeat(4);
o1
     .mergeWith(o2)...
```

See github.com/douglascraigschmidt/LiveLessons/tree/master/Reactive/Observable/ex1

Applying Key Methods in the Observable Class to ex1

- testFractionMultiplication2()
  - Performs BigFraction reduction & multiplication using two synchronous Observable streams that are merged together
  - Demonstrates the just(), map(), blockingSubscribe(), fromCallable(), repeat(), & mergeWith() methods

```
Observable<BigFraction> o1 =
Observable
   .just(BigFraction.valueOf(100, 3),
         BigFraction.valueOf(100, 4),
         BigFraction.valueOf(100, 2),
        BigFraction.valueOf(100, 1));
Observable<BigFraction> o2 =
Observable
     .fromCallable(() ->
         BigFractionUtils.
             makeBigFraction
               (random, true))
     .repeat(4);
o1
     .mergeWith(o2)...
```

See Reactive/Observable/ex1/src/main/java/ObservableEx.java

Applying Key Methods in the Observable Class to ex1

- The fromCallable() method
  - Returns an Observable that, when an observer subscribes to it, does certain things

```
static <T> Observable<T>
  fromCallable(Callable<? extends T>
                 callable)
```

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

Applying Key Methods in the Observable Class to ex1

- The fromCallable() method
  - Returns an Observable that, when an observer subscribes to it, does certain things
    - Invokes a Callable param

```
static <T> Observable<T>
    fromCallable(Callable<? extends T>
                 callable)
```

Interface Callable<V>

Type Parameters:

V - the result type of method call

All Known Subinterfaces:

DocumentationTool.DocumentationTask, JavaCompiler.CompilationTask

Functional Interface:

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

See docs.oracle.com/javase/8/docs/api/java/util/concurrent/Callable.html

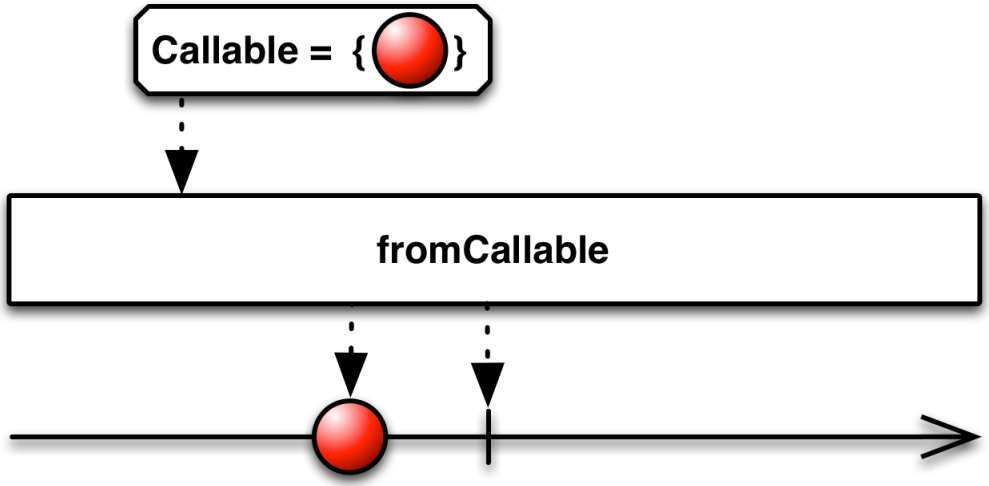
Applying Key Methods in the Observable Class to ex1

- The fromCallable() method
  - Returns an Observable that, when an observer subscribes to it, does certain things
    - Invokes a Callable param
    - The returned Observable emits the value returned from the Callable

```
static <T> Observable<T>
   fromCallable(Callable<? extends T>
                      callable)
```

Applying Key Methods in the Observable Class to ex1

- The fromCallable() method
  - Returns an Observable that, when an observer subscribes to it, does certain things
  - This factory method adapts non-reactive input sources into the reactive model




```
Observable
   .fromCallable
     (()
      -> BigFractionUtils
        .makeBigFraction(random,
                         true))
```

Applying Key Methods in the Observable Class to ex1

- The fromCallable() method
  - Returns an Observable that, when an observer subscribes to it, does certain things
  - This factory method adapts non-reactive input sources into the reactive model
  - This method defers executing the Callable until an observer subscribes to the Observable
    - i.e., it is "lazy"

```
Observable
   .fromCallable
     (()
      -> BigFractionUtils
        .makeBigFraction(random,
                         true))
```

Applying Key Methods in the Observable Class to ex1

- The fromCallable() method
  - Returns an Observable that, when an observer subscribes to it, does certain things
  - This factory method adapts non-reactive input sources into the reactive model
  - This method defers executing the Callable until an observer subscribes to the Observable
    - i.e., it is "lazy"

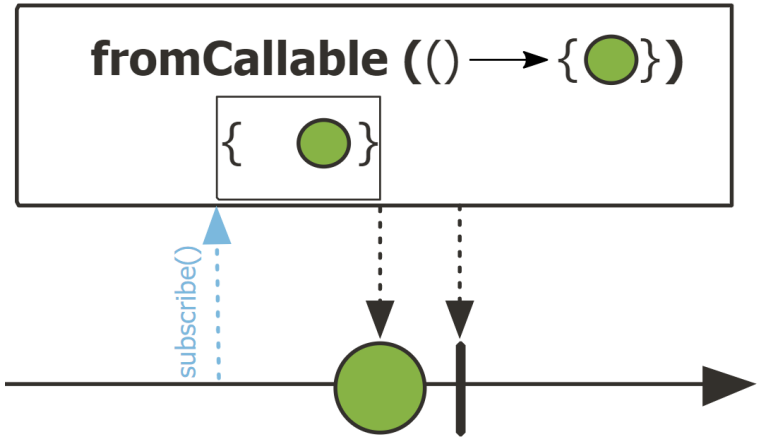
Conversely, Observable.just() is "eager"

```
Observable
   .just(BigFraction.valueOf(100,3),
         BigFraction.valueOf(100,4),
         BigFraction.valueOf(100,2),
         BigFraction.valueOf(100,1))
   ...
```

See earlier discussion of Observable.just() in this lesson

Applying Key Methods in the Observable Class to ex1

- The fromCallable() method
  - Returns an Observable that, when an observer subscribes to it, does certain things
  - This factory method adapts non-reactive input sources into the reactive model
  - This method defers executing the Callable until an observer subscribes to the Observable
  - Project Reactor's method Mono .fromCallable() is similar



See projectreactor.io/docs/core/release/api/reactor/core/publisher/Mono.html#fromCallable

Applying Key Methods in the Observable Class to ex1

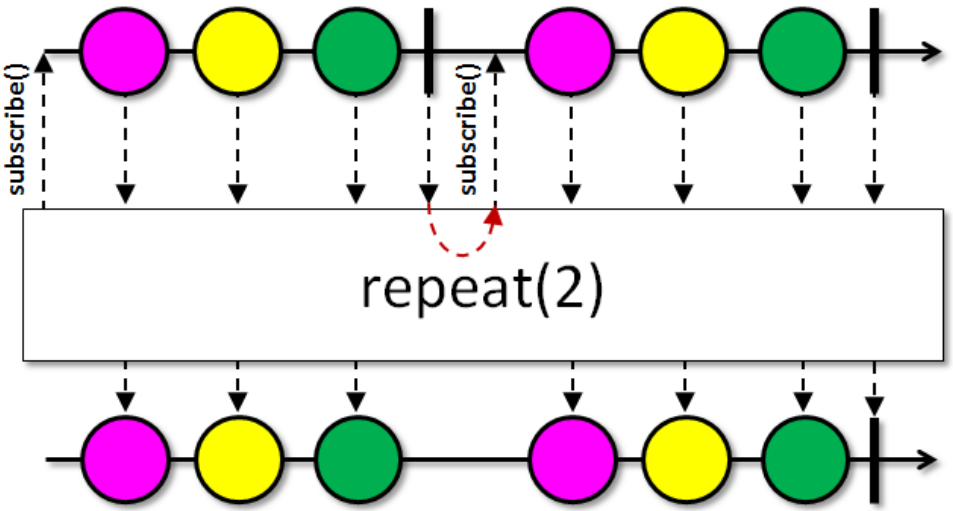
- The repeat() method
  - Returns an Observable that repeats the sequence of items emitted by the given Observable at most count # of times

```
Observable<T> repeat(long times)
```

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

Applying Key Methods in the Observable Class to ex1

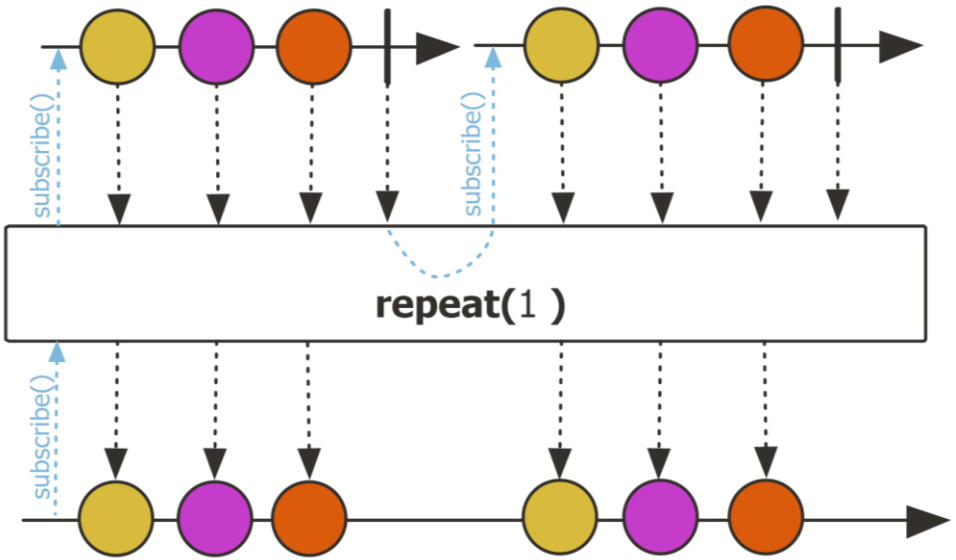
- The repeat() method
  - Returns an Observable that repeats the sequence of items emitted by the given Observable at most count # of times
  - This method does not operate by default on a particular Scheduler



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

Applying Key Methods in the Observable Class to ex1

- The repeat() method
  - Returns an Observable that repeats the sequence of items emitted by the given Observable at most count # of times
  - This method does not operate by default on a particular Scheduler
  - Project Reactor's Flux.repeat() works the same



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

Applying Key Methods in the Observable Class to ex1

- The mergeWith() method
  - Merges the sequence of items of the current Observable with the success value of the other ObservableSource param

```
Observable<T> mergeWith
   (ObservableSource<? extends T>
      other)
```

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

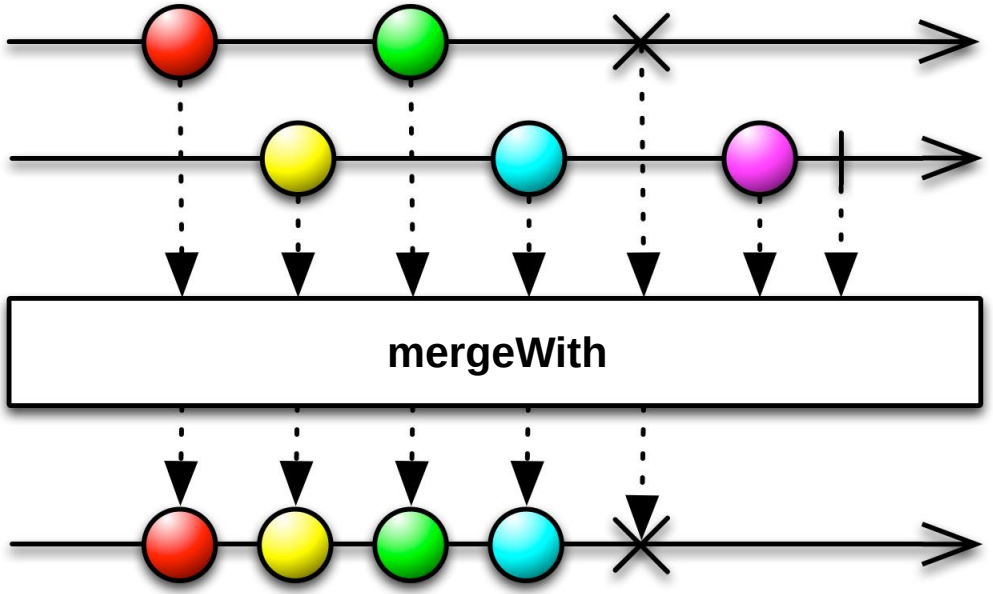
Applying Key Methods in the Observable Class to ex1

- The mergeWith() method
  - Merges the sequence of items of the current Observable with the success value of the other ObservableSource param
    - Returns the new merged Observable instance

```
Observable<T> mergeWith
   (ObservableSource<? extends T>
      other)
```

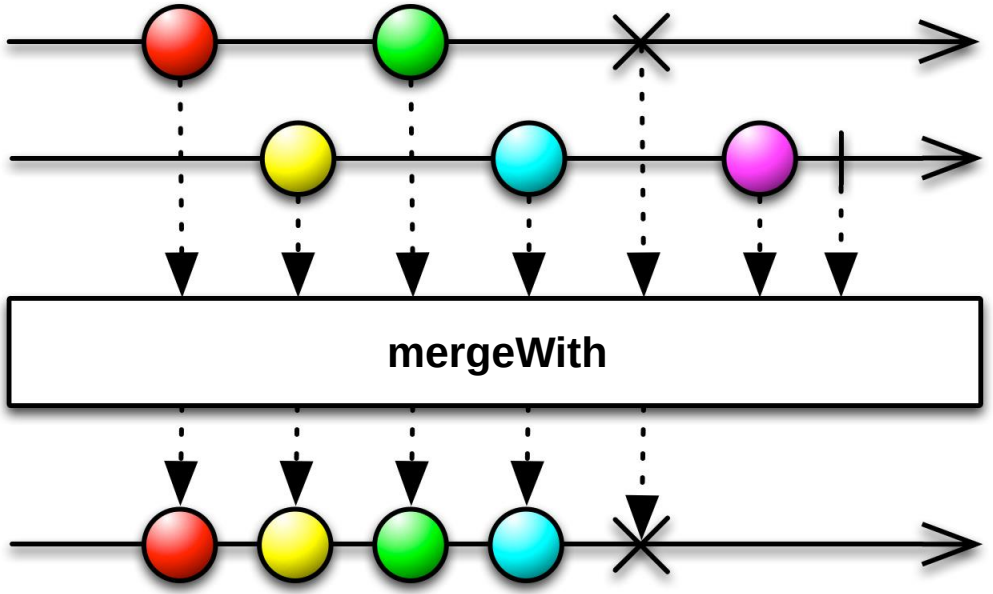
Applying Key Methods in the Observable Class to ex1

- The mergeWith() method
  - Merges the sequence of items of the current Observable with the success value of the other ObservableSource param
  - This method combines items emitted by multiple Observable Sources so that they appear as a single ObservableSource



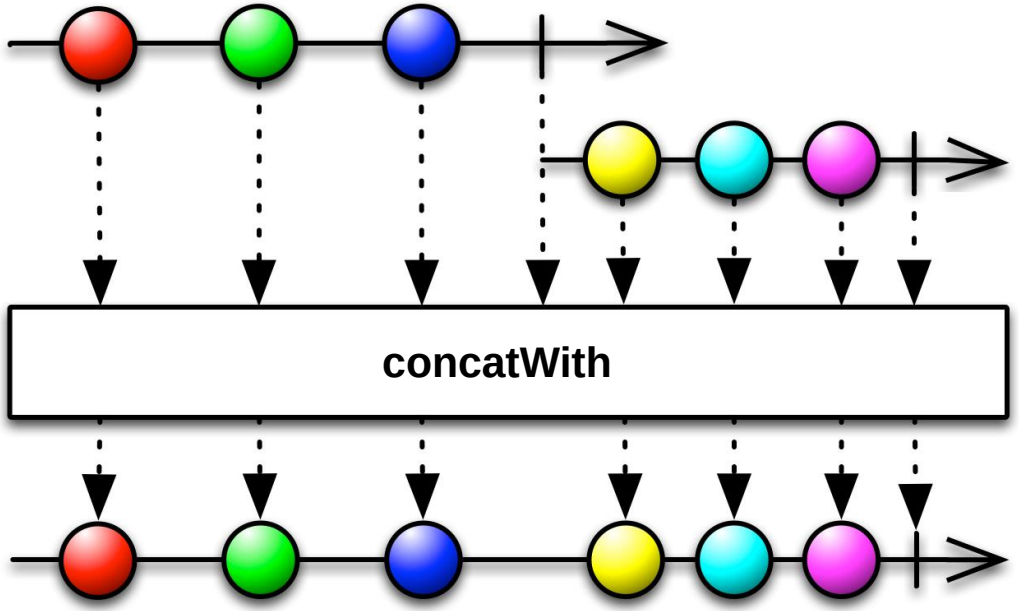
Applying Key Methods in the Observable Class to ex1

- The mergeWith() method
  - Merges the sequence of items of the current Observable with the success value of the other ObservableSource param
  - This method combines items emitted by multiple Observable Sources so that they appear as a single ObservableSource
    - This merging may interleave the items



Applying Key Methods in the Observable Class to ex1

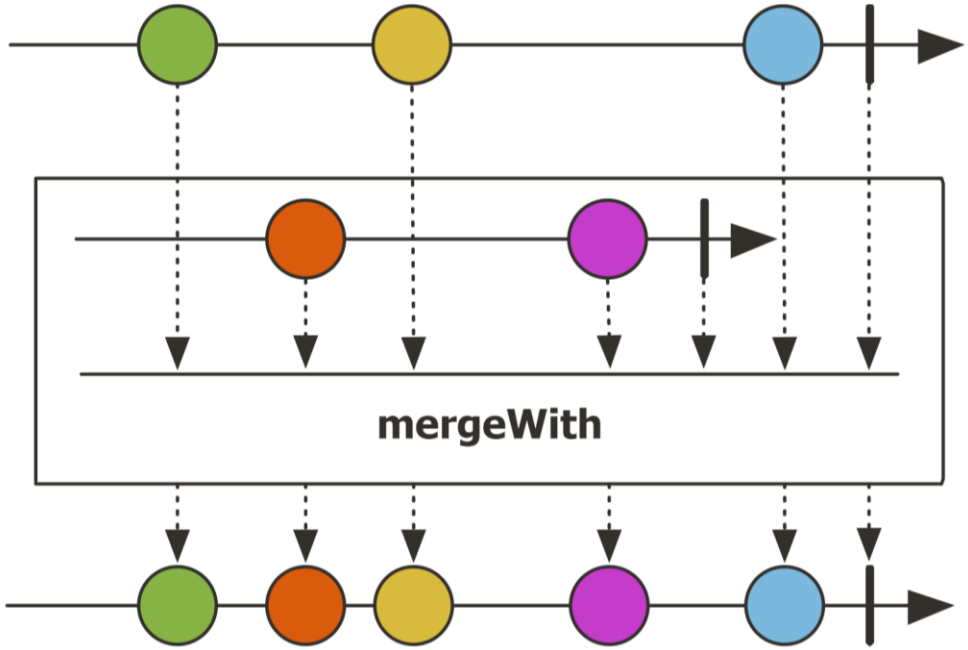
- The mergeWith() method
  - Merges the sequence of items of the current Observable with the success value of the other ObservableSource param
  - This method combines items emitted by multiple Observable Sources so that they appear as a single ObservableSource
    - This merging may interleave the items
    - Use concatWith() to avoid interleaving



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

Applying Key Methods in the Observable Class to ex1

- The mergeWith() method
  - Merges the sequence of items of the current Observable with the success value of the other ObservableSource param
  - This method combines items emitted by multiple Observable Sources so that they appear as a single ObservableSource
  - Project Reactor's method Flux.mergeWith() works the same



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

Applying Key Methods in the Observable Class to ex1

- The mergeWith() method
  - Merges the sequence of items of the current Observable with the success value of the other ObservableSource param
  - This method combines items emitted by multiple Observable Sources so that they appear as a single ObservableSource
  - Project Reactor's method Flux.mergeWith() works the same
  - Similar to the Stream.concat() method in Java Streams

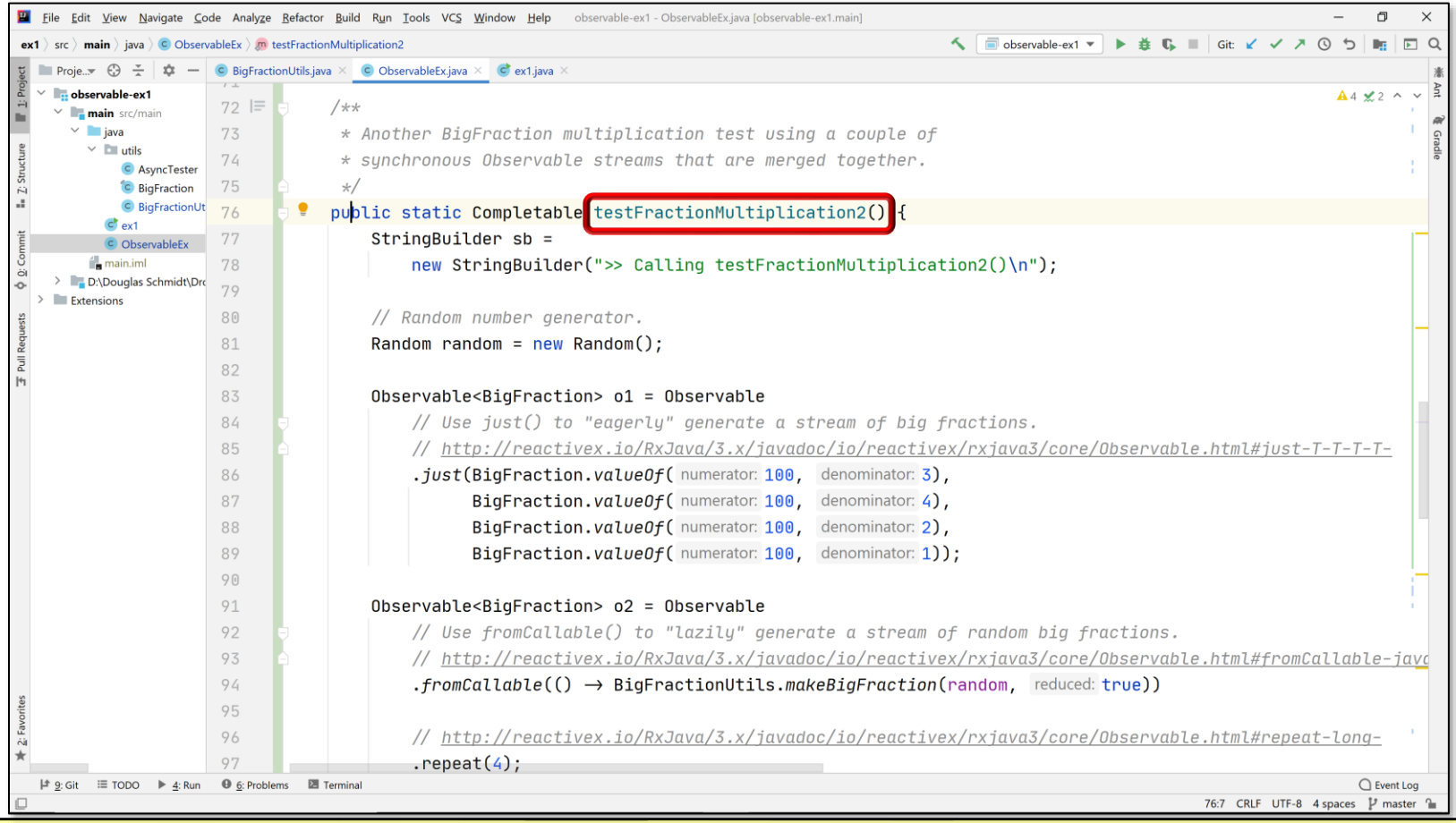
concat

```
static <T> Stream<T> concat(Stream<? extends T> a,
                            Stream<? extends T> b)
```

Creates a lazily concatenated stream whose elements are all the elements of the first stream followed by all the elements of the second stream. The resulting stream is ordered if both of the input streams are ordered, and parallel if either of the input streams is parallel. When the resulting stream is closed, the close handlers for both input streams are invoked.

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

Applying Key Methods in the Observable Class to ex1



See github.com/douglascraigschmidt/LiveLessons/tree/master/Reactive/Observable/ex1

End of Applying Key Methods in the Observable Class (Part 1)