Applying Basic Java CompletableFuture Features

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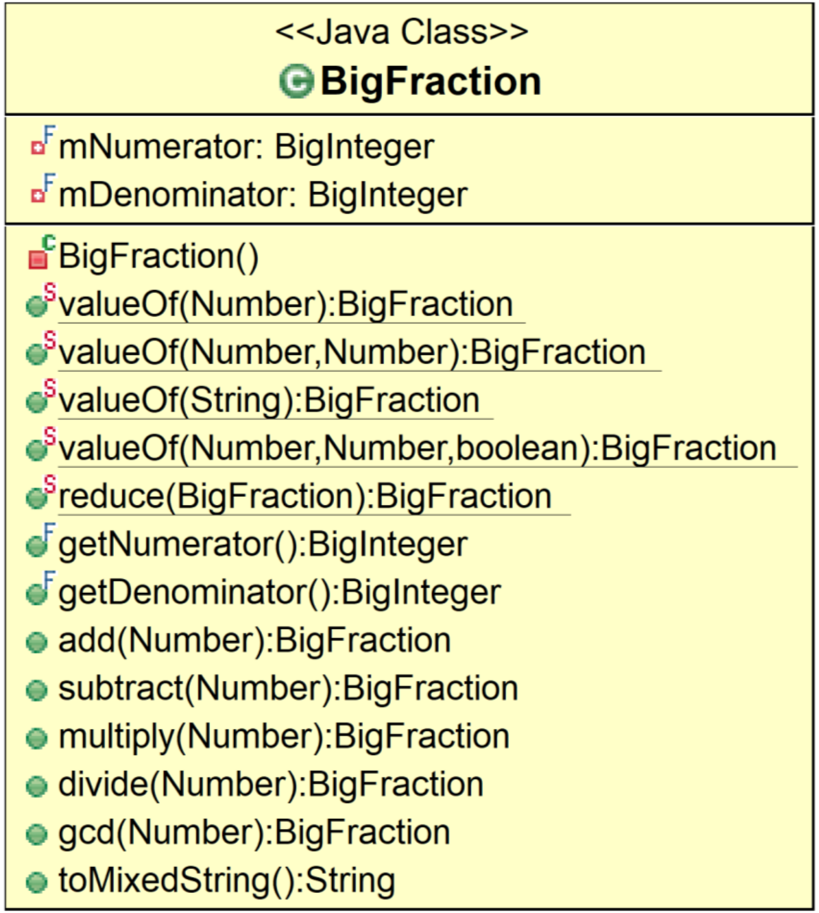
Learning Objectives in this Part of the Lesson

- Understand the basic completable futures features
- Know how to apply these basic features to operate on big fractions



<<Java Class>>

BigFraction

mNumerator: BigInteger

mDenominator: BigInteger

BigFraction()

valueOf(Number):BigFraction

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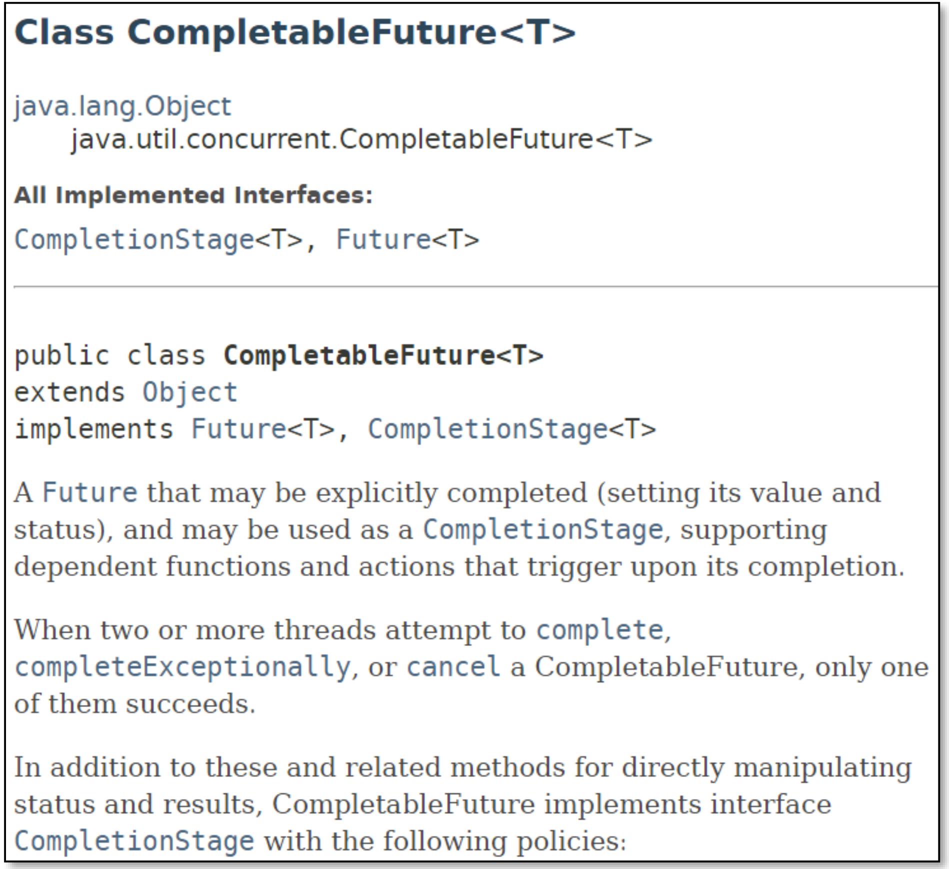
gcd(Number):BigFraction

toMixedString():String

See github.com/douglascraigschmidt/LiveLessons/tree/master/Java8/ex8

Learning Objectives in this Part of the Lesson

- Understand the basic completable futures features
- Know how to apply these basic features to operate on big fractions
- Recognize limitations with these basic features



Class CompletableFuture<T>

java.lang.Object
    java.util.concurrent.CompletableFuture<T>

All Implemented Interfaces:

CompletionStage<T>, Future<T>

```
public class CompletableFuture<T>
extends Object
implements Future<T>, CompletionStage<T>
```

A Future that may be explicitly completed (setting its value and status), and may be used as a CompletionStage, supporting dependent functions and actions that trigger upon its completion.

When two or more threads attempt to complete, completeExceptionally, or cancel a CompletableFuture, only one of them succeeds.

In addition to these and related methods for directly manipulating status and results, CompletableFuture implements interface CompletionStage with the following policies:

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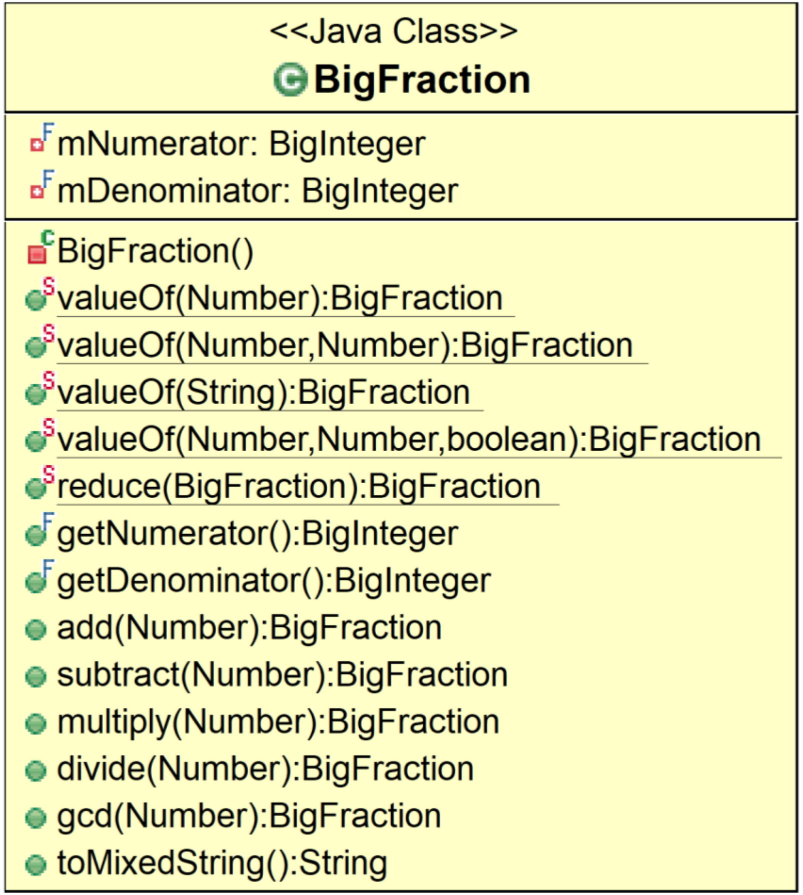
- We show how to apply basic completable future features in the context of BigFraction



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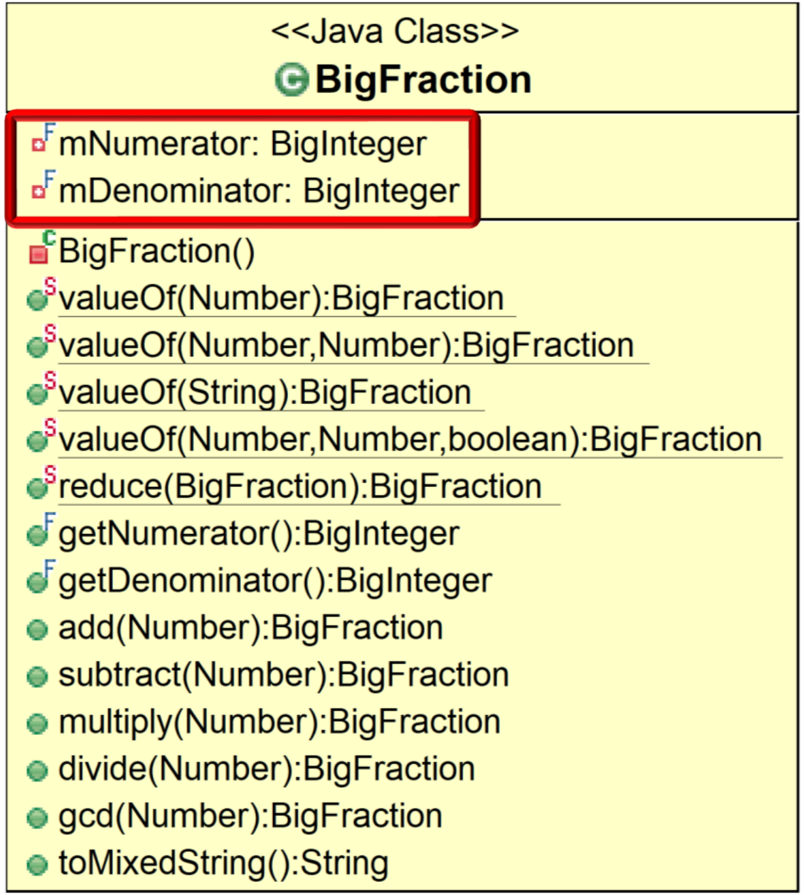
See [LiveLessons/blob/master/Java8/ex8/src/utils/BigFraction.java]()

Applying Basic CompletableFuture Features

- We show how to apply basic completable future features in the context of BigFraction
  - Arbitrary-precision fraction, utilizing BigIntegers for numerator & denominator



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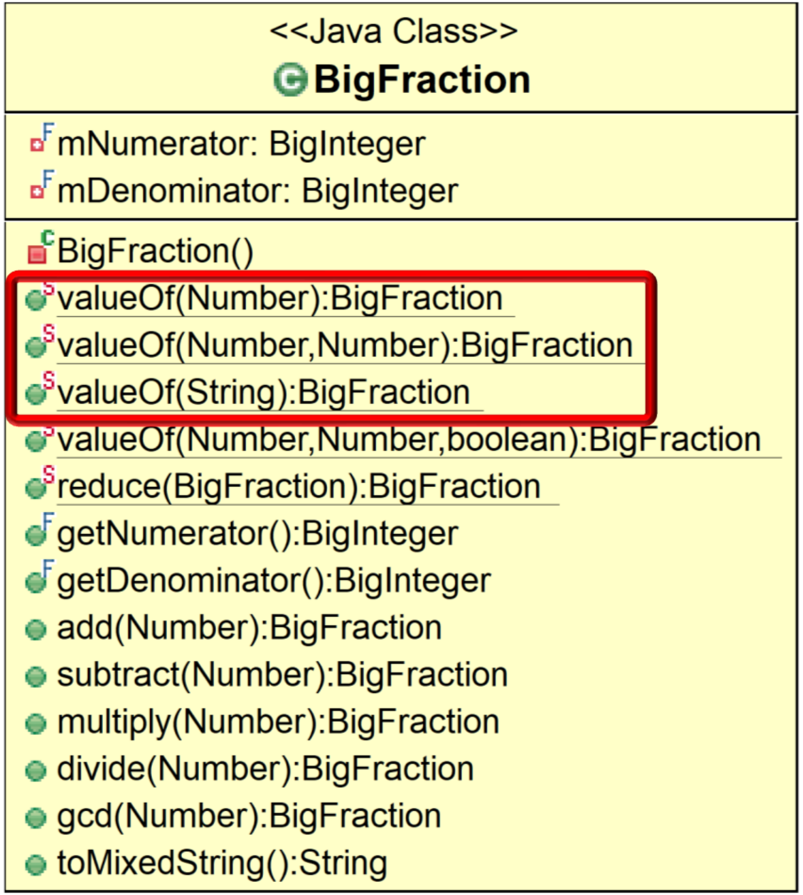
See docs.oracle.com/javase/8/docs/api/java/math/BigInteger.html

Applying Basic CompletableFuture Features

- We show how to apply basic completable future features in the context of BigFraction
  - Arbitrary-precision fraction, utilizing BigIntegers for numerator & denominator
  - Factory methods for creating "reduced" fractions, e.g.
    - 44/55 → 4/5
    - 12/24 → 1/2
    - 144/216 → 2/3



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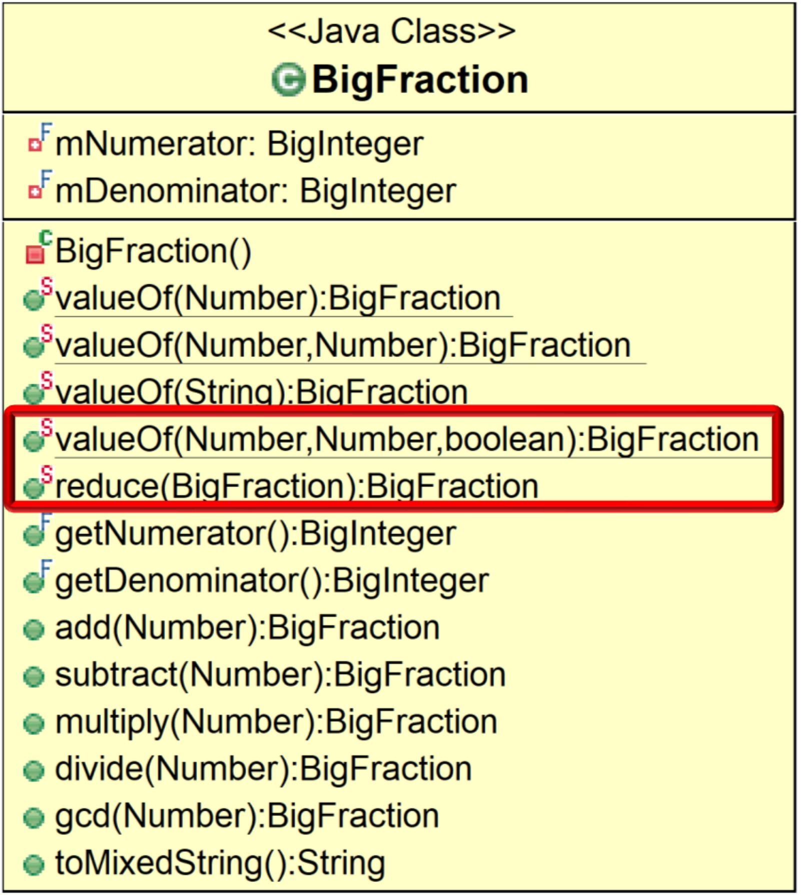
- We show how to apply basic completable future features in the context of BigFraction
  - Arbitrary-precision fraction, utilizing BigIntegers for numerator & denominator
  - Factory methods for creating "reduced" fractions
  - Factory methods for creating "non-reduced" fractions (& then reducing them)
    - e.g., 12/24 (→ 1/2)



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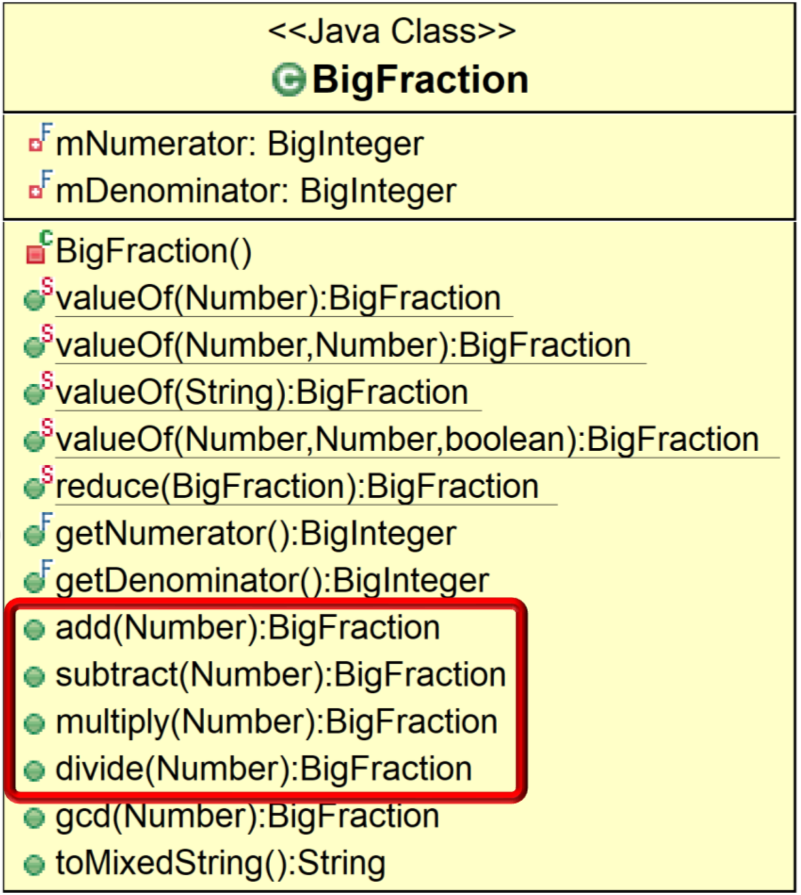
  - Arbitrary-precision fraction, utilizing BigIntegers for numerator & denominator
  - Factory methods for creating "reduced" fractions
  - Factory methods for creating "non-reduced" fractions (& then reducing them)
  - Arbitrary-precision fraction arithmetic
    - e.g., 18/4 ×2/3 = 3



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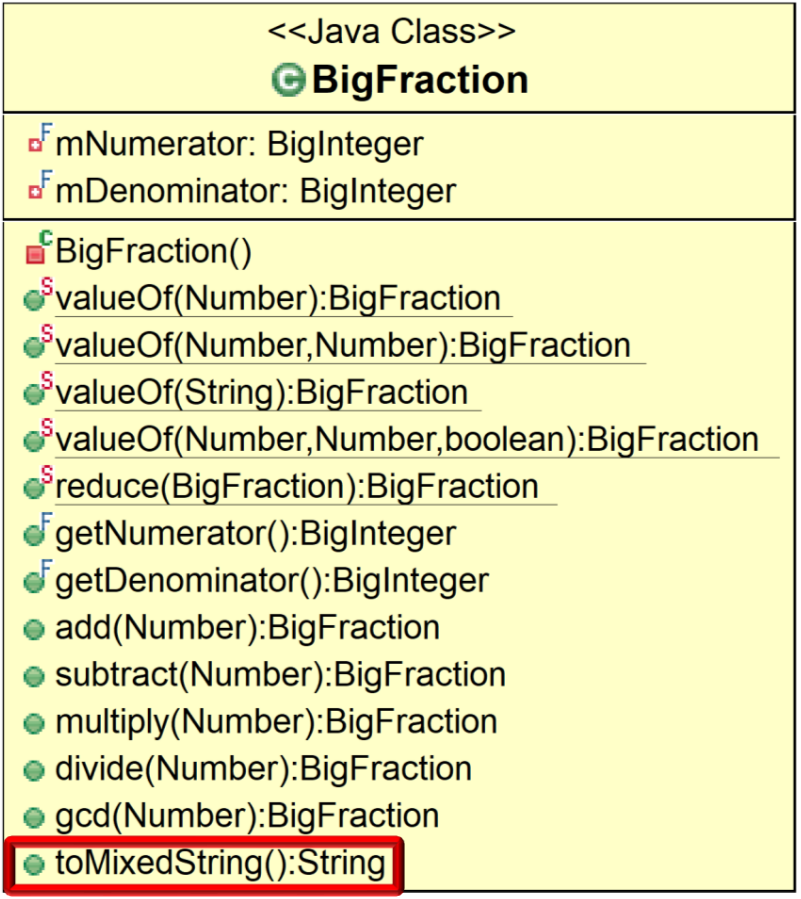
- We show how to apply basic completable future features in the context of BigFraction
  - Arbitrary-precision fraction, utilizing BigIntegers for numerator & denominator
  - Factory methods for creating "reduced" fractions
  - Factory methods for creating "non-reduced" fractions (& then reducing them)
  - Arbitrary-precision fraction arithmetic
  - Create a mixed fraction from an improper fraction
    - e.g., 18/4 → 4 1/2



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See www.mathsisfun.com/improper-fractions.html

Applying Basic CompletableFuture Features

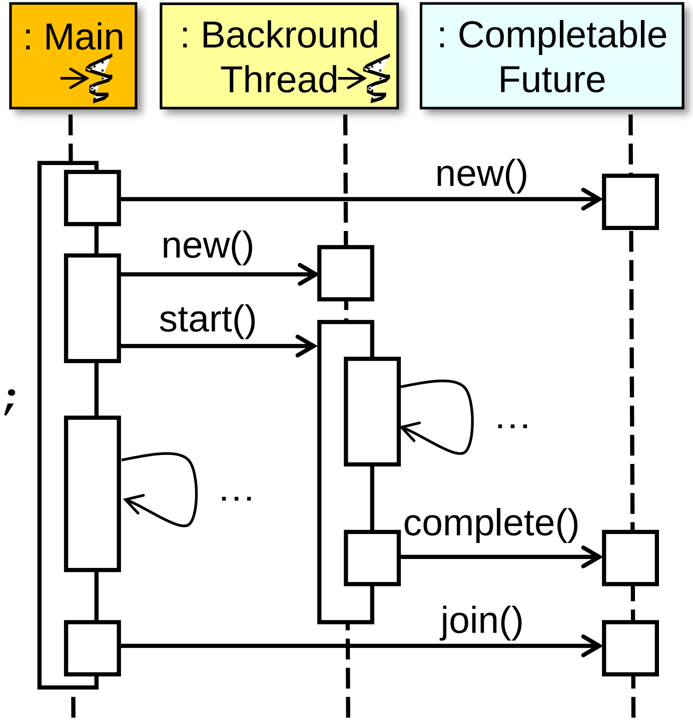
- Multiplying big fractions w/a completable future

```
CompletableFuture<BigFraction> future
   = new CompletableFuture<>();

new Thread (() -> {
   BigFraction bf1 =
      new BigFraction("62675744/15668936");
   BigFraction bf2 =
      new BigFraction("609136/913704");

   future.complete(bf1.multiply(bf2));
}).start();

...
System.out.println(future.join().toMixedString());
```



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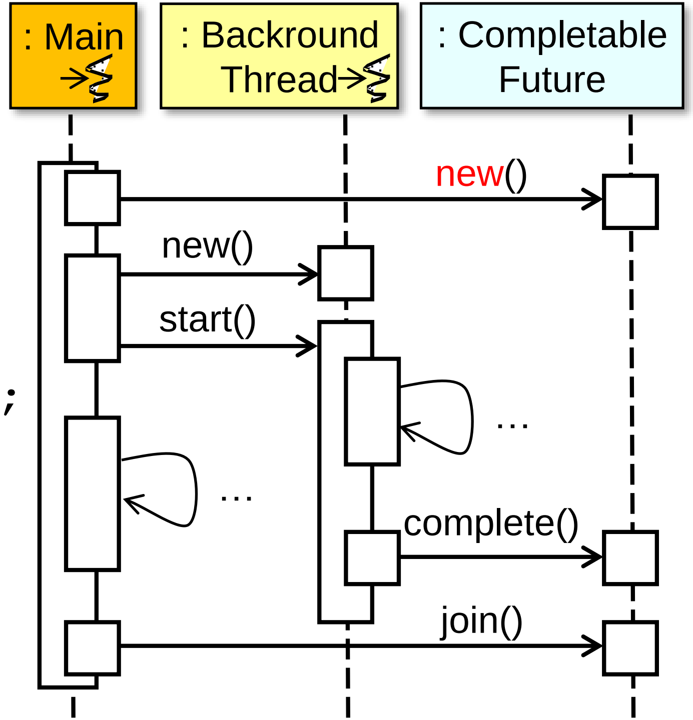
Make "empty" future



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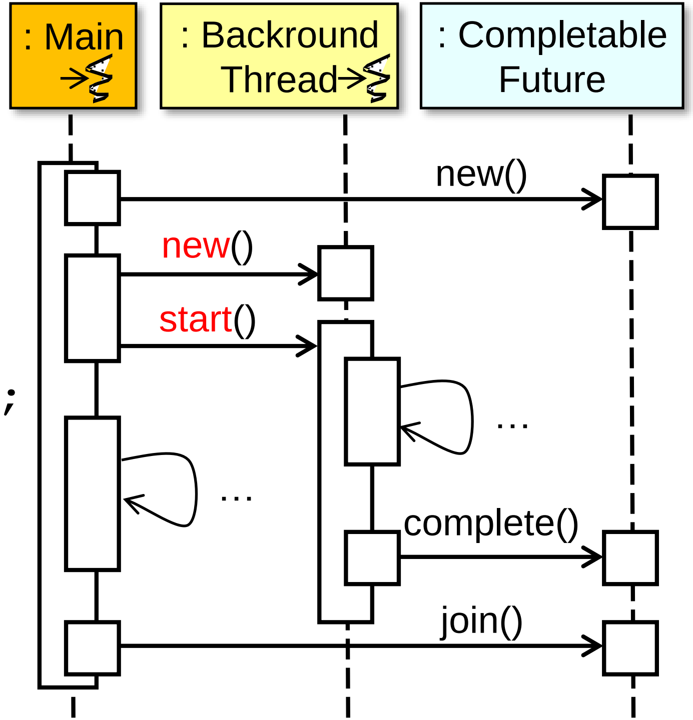
Start computation in a background thread



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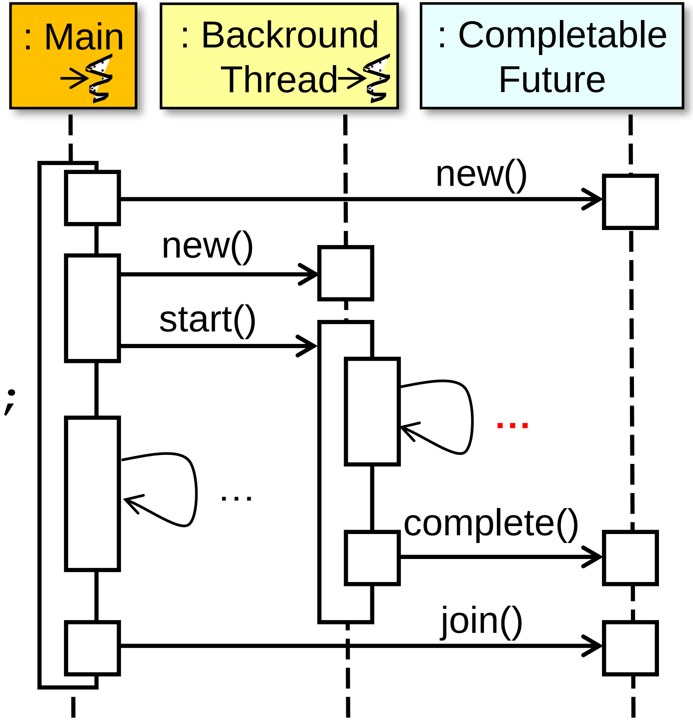

The computation multiplies BigFractions (via BigIntegers)

See docs.oracle.com/javase/8/docs/api/java/math/BigInteger.html

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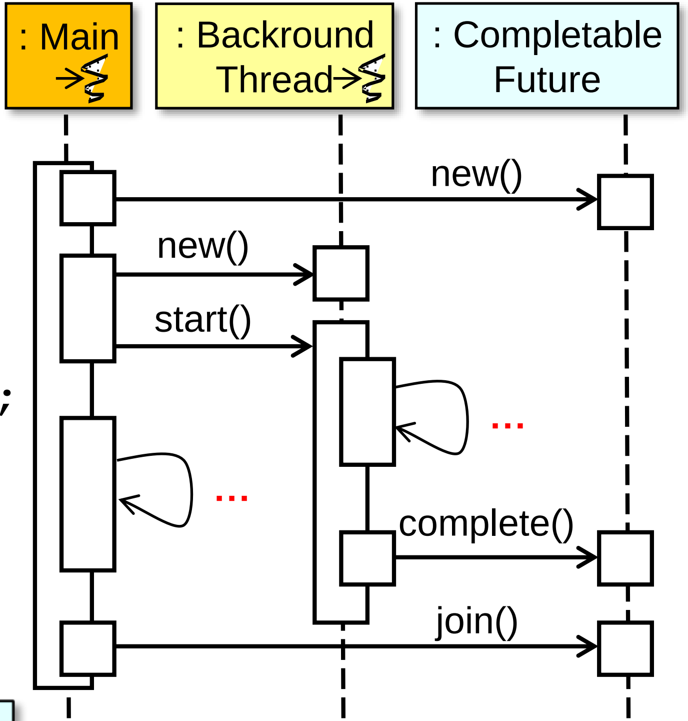
These computations run concurrently



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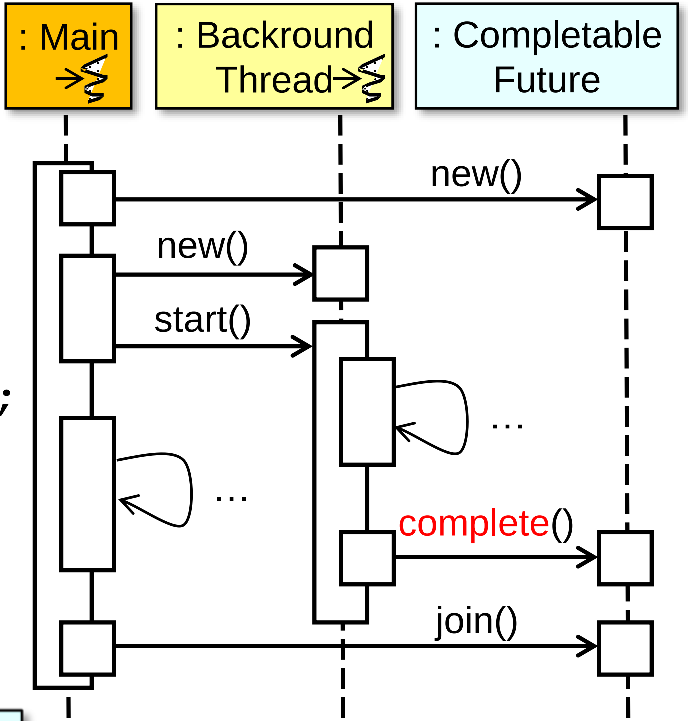
Explicitly complete the future w/result



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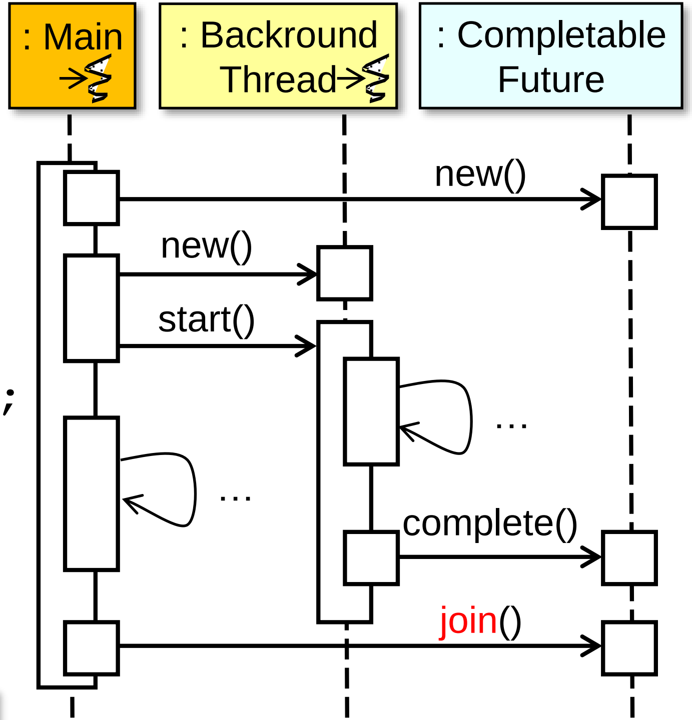

join() blocks until result is computed

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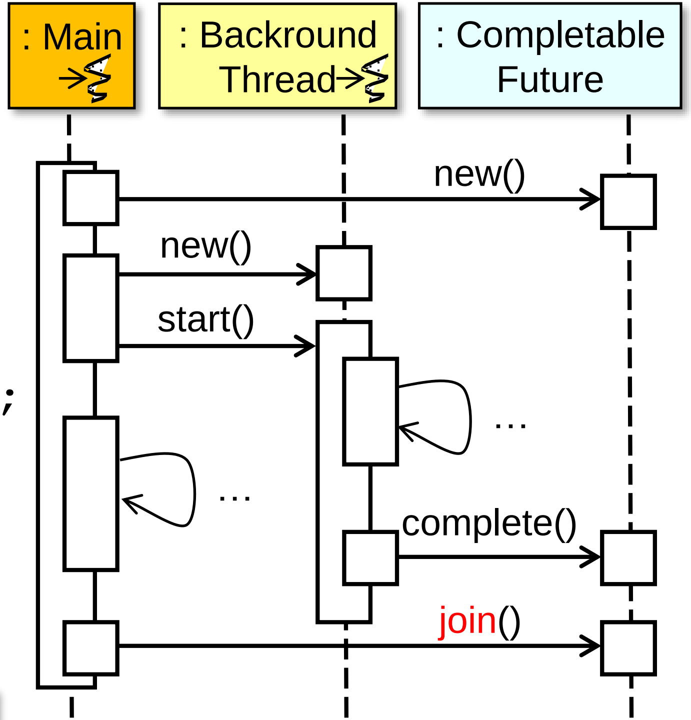

Convert result to a mixed fraction

See hwww.mathsisfun.com/mixed-fractions.html

Limitations with Basic CompletableFutures Features

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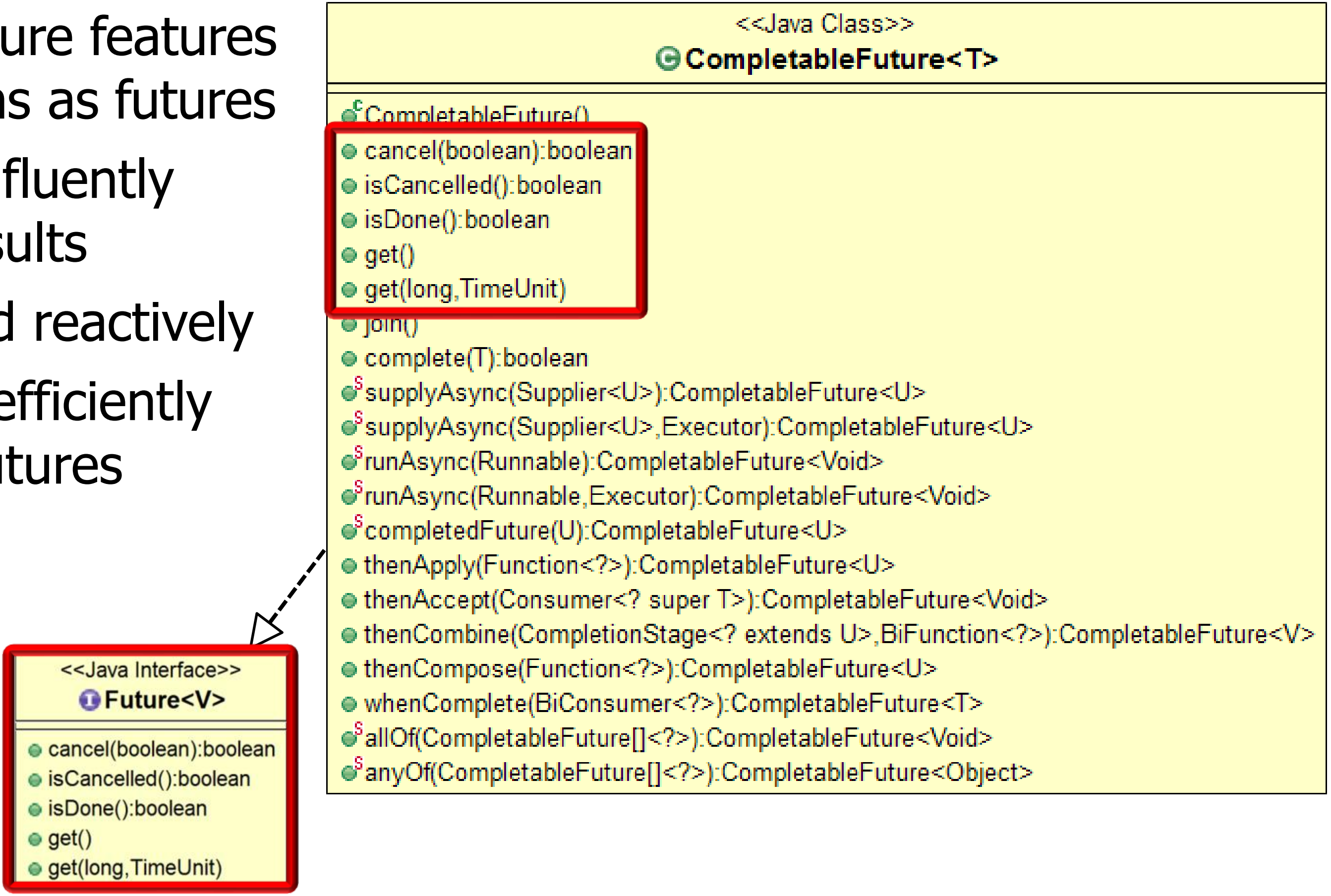
- Basic CompletableFuture features have similar limitations as futures
  - *Cannot* be chained fluently to handle async results
  - *Cannot* be triggered reactively
  - *Cannot* be treated efficiently as a *collection* of futures

LIMITED



<<Java Class>>
CompletableFuture<T>

CompletableFuture()
cancel(boolean):boolean
isCancelled():boolean
isDone():boolean
get()
get(long,TimeUnit)
join()
complete(T):boolean
supplyAsync(Supplier<U>):CompletableFuture<U>
supplyAsync(Supplier<U>,Executor):CompletableFuture<U>
runAsync(Runnable):CompletableFuture<Void>
runAsync(Runnable,Executor):CompletableFuture<Void>
completedFuture(U):CompletableFuture<U>
thenApply(Function<?>):CompletableFuture<U>
thenAccept(Consumer<? super T>):CompletableFuture<Void>
thenCombine(CompletionStage<? extends U>,BiFunction<?>):CompletableFuture<V>
thenCompose(Function<?>):CompletableFuture<U>
whenComplete(BiConsumer<?>):CompletableFuture<T>
allOf(CompletableFuture[]<?>):CompletableFuture<Void>
anyOf(CompletableFuture[]<?>):CompletableFuture<Object>

<<Java Interface>>
Future<V>

cancel(boolean):boolean
isCancelled():boolean
isDone():boolean
get()
get(long,TimeUnit)

See earlier lesson on "*Evaluating the Pros & Cons of Java Futures*"

Limitations with Basic CompletableFutures Features

- e.g., join() blocks until the future is completed..

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System.out.println(future.join().toMixedString());
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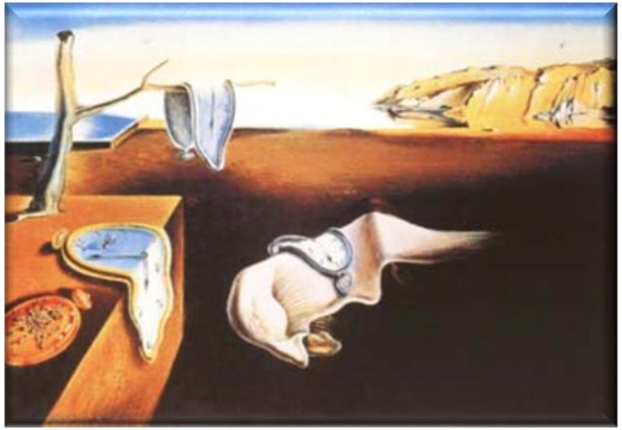

This blocking call underutilizes cores & increases overhead

Limitations with Basic CompletableFutures Features

- ..using timed get() is also problematic..

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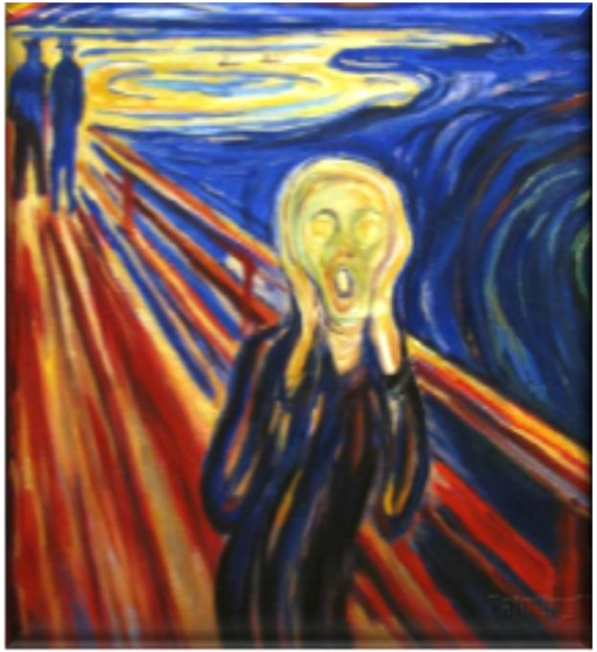
System.out.println(future.get(1, SECONDS).toMixedString());
```

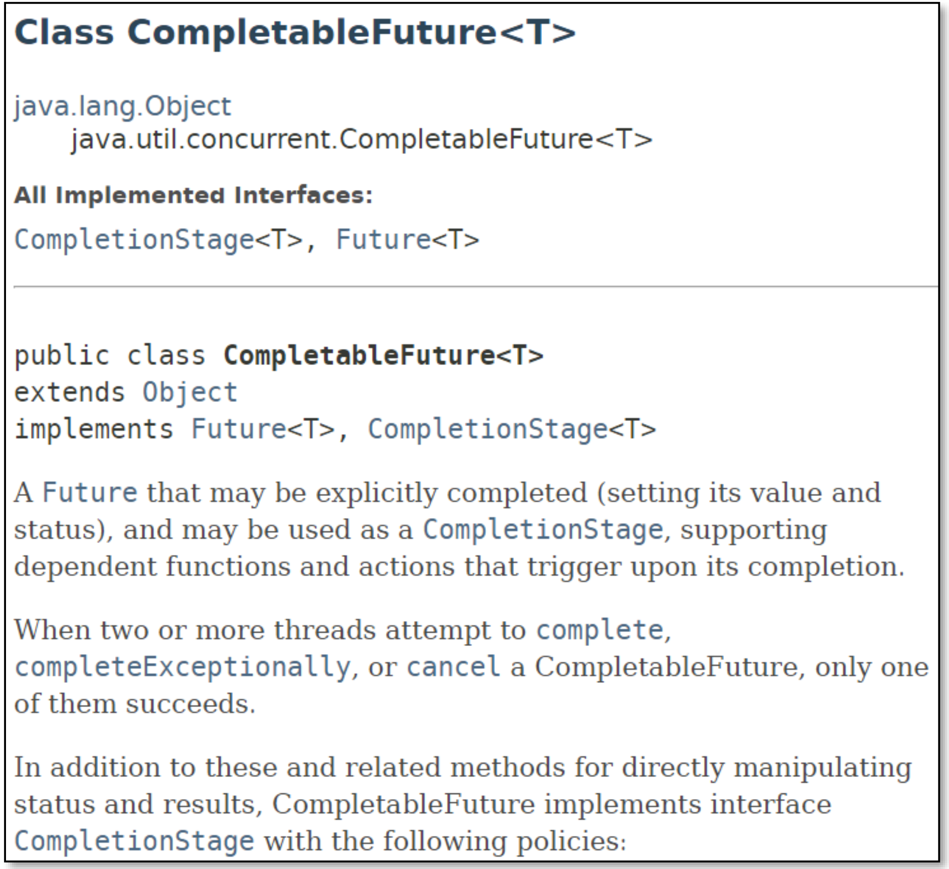


Using a timeout to bound the blocking duration is inefficient & error-prone

See crondev.blog/2017/01/23/timeouts-with-java-8-completablefuture-youre-probably-doing-it-wrong

Limitations with Basic CompletableFutures Features

- We therefore need to leverage the advanced features of completable futures



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End of Applying Basic Java CompletableFuture Features