Applying Basic Java
CompletableFuture Features

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Learning Objectives in this Part of the Lesson

• Understand the basic features in the Java completable futures framework

• Know how to apply these basic features to operate on big fractions

See earlier lesson on “Programming with Java Futures”
Learning Objectives in this Part of the Lesson

• Understand the basic features in the Java completable futures framework
• Know how to apply these basic features to operate on big fractions
• Recognize limitations with these basic features

```java
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:
```
Applying Basic Completable Future Features
Applying Basic CompletableFuture Features

- Multiplying big fractions w/a completable future

```java
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());
```

See [github.com/douglascraigschmidt/LiveLessons/tree/master/Java8/ex8](https://github.com/douglascraigschmidt/LiveLessons/tree/master/Java8/ex8)
Applying Basic CompletableFuture Features

- Multiplying big fractions w/ a completable future

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new Thread(() -> {
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    future.complete(bf1.multiply(bf2));
}).start();

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

Create a future that’s "incomplete"
Applying Basic CompletableFuture Features

- Multiplying big fractions w/a completable future

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

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

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

Start computation in a background thread
Applying Basic CompletableFuture Features

- Multiplying big fractions w/a completable future

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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());
```

*The computation multiplies BigFractions (via BigIntegers)*

See [docs.oracle.com/javase/8/docs/api/java/math/BigInteger.html](https://docs.oracle.com/javase/8/docs/api/java/math/BigInteger.html)
Applying Basic CompletableFuture Features

• Multiplying big fractions w/a completable future

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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();
```

These computations run concurrently

```java
System.out.println(future.join().toMixedString());
```
Applying Basic CompletableFuture Features

- Multiplying big fractions w/a completable future

```java
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();

Explicitly complete the future w/result

... System.out.println(future.join().toMixedString());
```
Applying Basic CompletableFuture Features

- Multiplying big fractions w/a completable future

```java
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new Thread(() -> {
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    future.complete(bf1.multiply(bf2));
}).start();
```

`.join()` blocks until result is computed

```java
System.out.println(future.join().toMixedString());
```
Applying Basic CompletableFuture Features

- Multiplying big fractions w/ a completable future

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```

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

See [www.mathsisfun.com/mixed-fractions.html](http://www.mathsisfun.com/mixed-fractions.html)
Limitations with Basic CompletableFuture Features
Limitations with Basic CompletableFuture Features

- 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

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

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    BigFraction bf2 = new BigFraction("609136/913704");

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

... Blocking underutilizes cores & increases overhead...

```java
System.out.println(future.join().toMixedString());
```
Limitations with Basic CompletableFutures Features

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

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

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

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

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

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

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

See [docs.oracle.com/javase/8/docs/api/java/util/concurrent/CompletableFuture.html](docs.oracle.com/javase/8/docs/api/java/util/concurrent/CompletableFuture.html)

```java
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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:
```
End of Applying Basic Java CompletableFuture Features