Overview of 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
  - e.g., get(), isDone(), isCanceled(), cancel(), join(), & complete()

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:

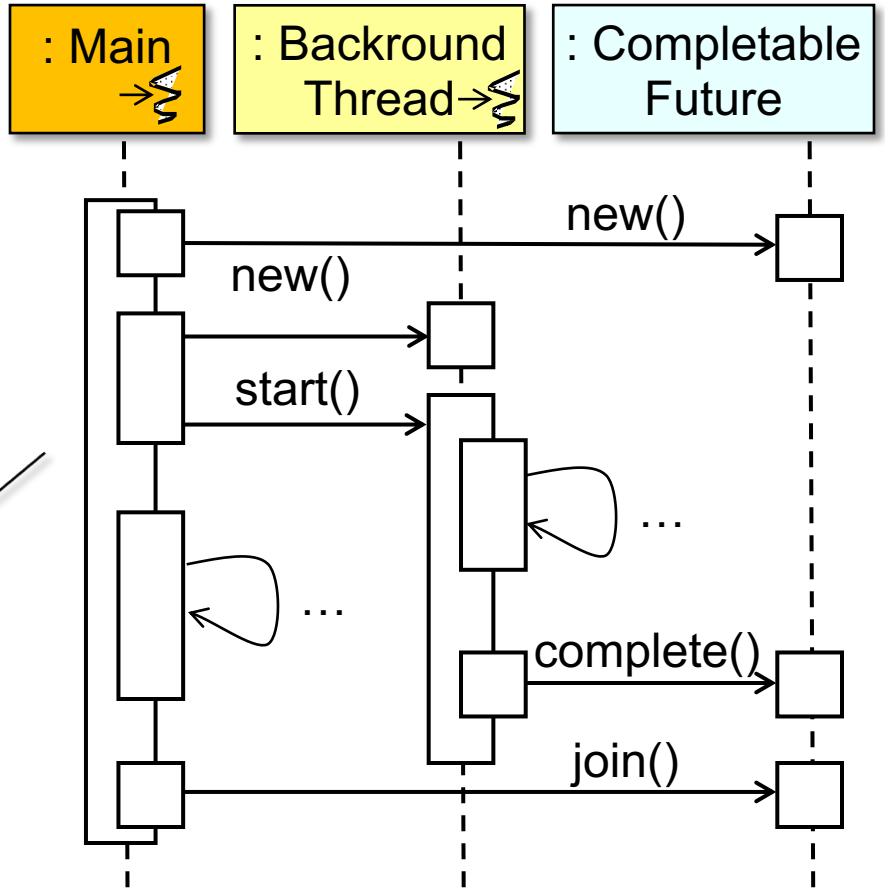
See docs.oracle.com/javase/8/docs/api/java/util/concurrent/CompletableFuture.html

Basic Completable Future Features

Basic CompletableFuture Features

- Basic CompletableFuture features

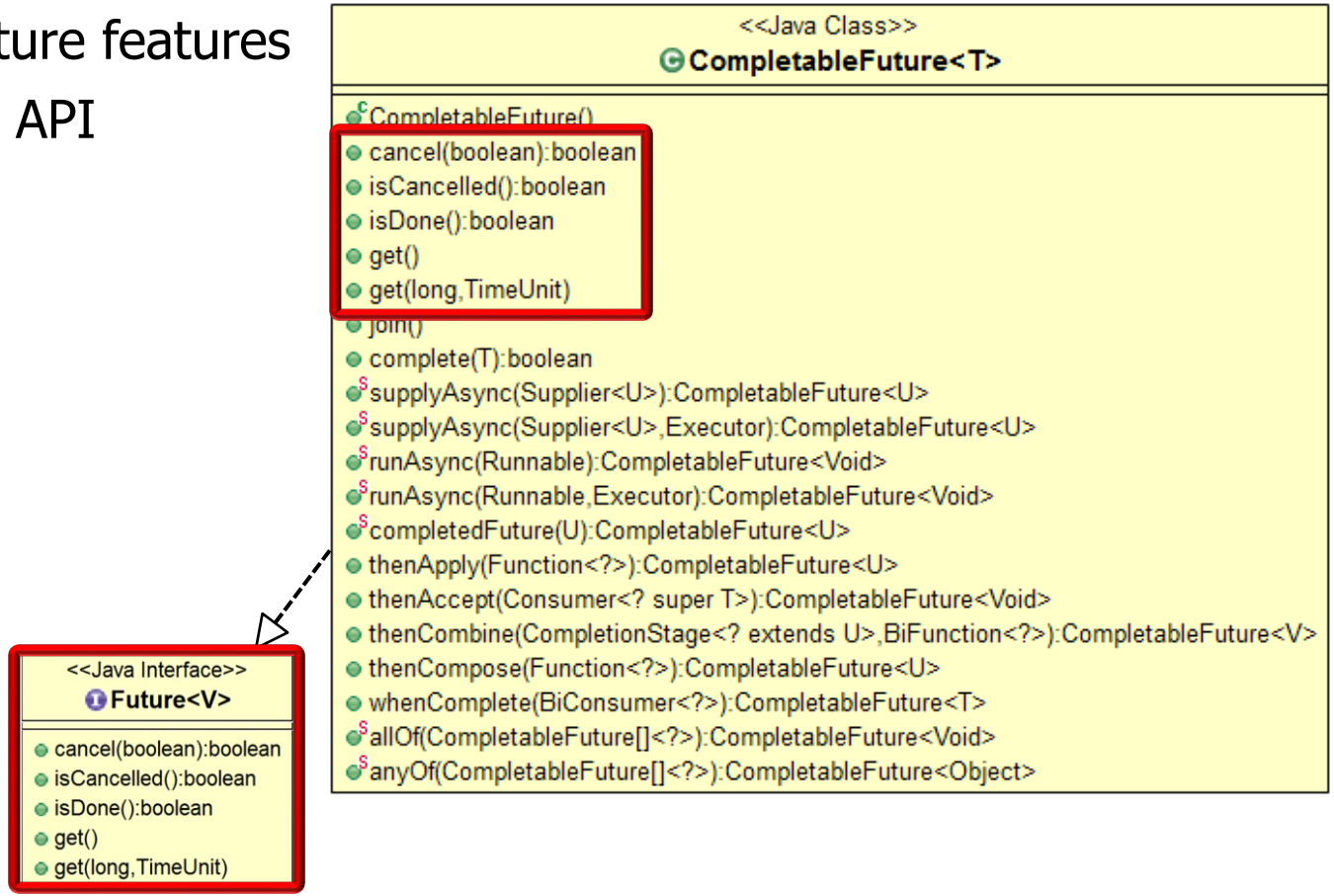
We showcase these basic features in case study ex8



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

Basic CompletableFuture Features

- Basic CompletableFuture features
  - Support the Future API



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

Basic CompletableFuture Features

- Basic CompletableFuture features
  - Support the Future API, e.g.
    - Can block, time-wait, & poll

```
String f1 = "62675744/15668936";
String f2 = "609136/913704";

ForkJoinTask<BigFraction> f =
   commonPool().submit(() -> {
     BigFraction bf1 =
       new BigFraction(f1);
     BigFraction bf2 =
       new BigFraction(f2);
     return bf1.multiply(bf2);
   });
...
BigFraction result = f.get();
// f.get(10, MILLISECONDS);
// f.get(0, 0);
```

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

Basic CompletableFuture Features

- Basic CompletableFuture features
  - Support the Future API, e.g.
    - Can block, time-wait, & poll
    - Can be cancelled & tested if cancelled/done

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String f1 = "62675744/15668936";
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ForkJoinTask<BigFraction> f =
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     BigFraction bf1 =
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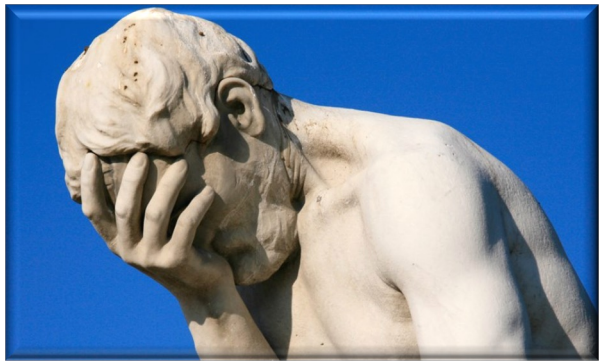
     BigFraction bf2 =
       new BigFraction(f2);
     return bf1.multiply(bf2);
   });
...
if (!(f.isDone()
      || !f.isCancelled()))
   f.cancel();
```

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

Basic CompletableFuture Features

- Basic CompletableFuture features
  - Support the Future API, e.g.
    - Can block, time-wait, & poll
    - Can be cancelled & tested if cancelled/done
      - cancel() doesn't interrupt the computation by default..



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   });
...
if (!(f.isDone()
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   f.cancel();
```
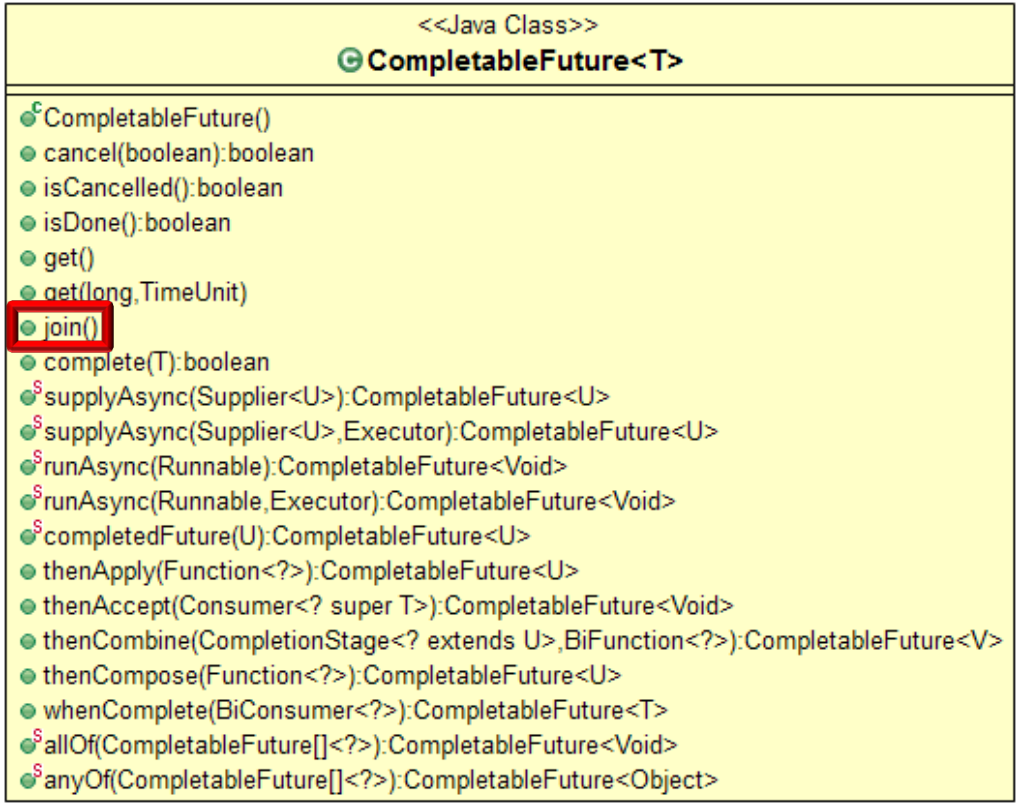

See www.nurkiewicz.com/2015/03/completablefuture-cant-be-interrupted.html

Basic CompletableFuture Features

- Basic CompletableFuture features
  - Support the Future API
  - Define a join() method



See docs.oracle.com/javase/8/docs/api/java/util/concurrent/CompletableFuture.html#join

Basic CompletableFuture Features

- Basic CompletableFuture features
  - Support the Future API
  - Define a join() method
    - Blocks awaiting results

<<Java Class>>
CompletableFuture<T>

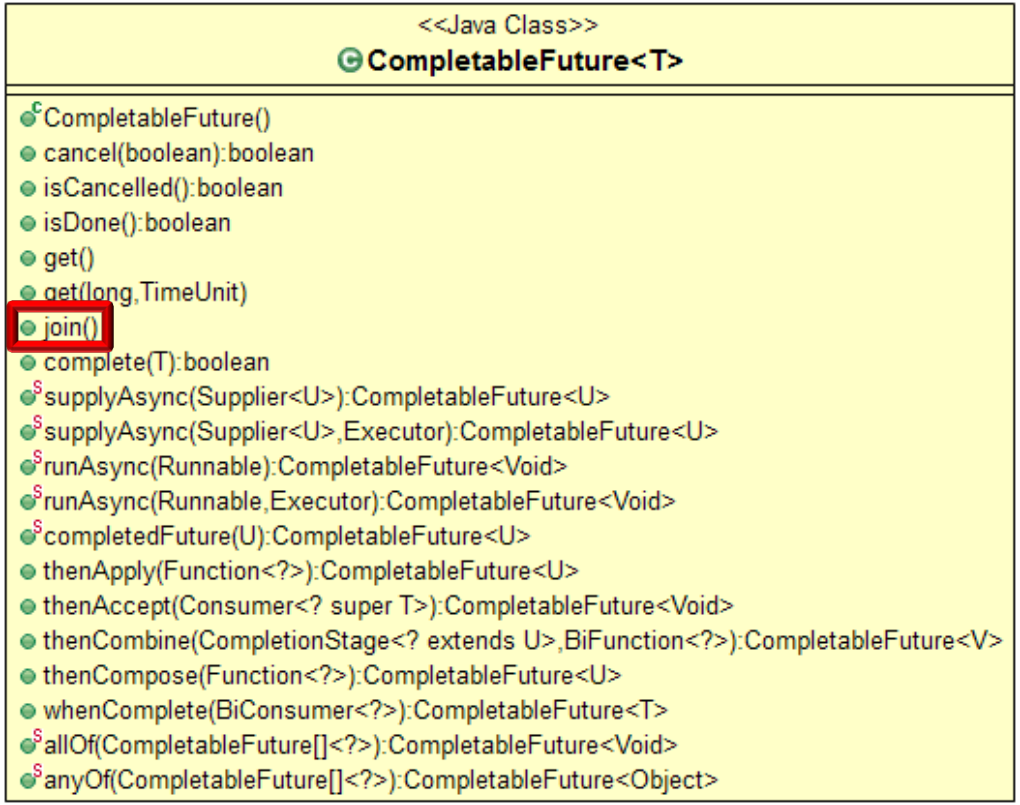
- CompletableFuture()
- cancel(boolean):boolean
- isCancelled():boolean
- isDone():boolean
- get()
- get(long,TimeUnit)
- join()
- complete(T):boolean
- supplyAsync(Supplier<U>):CompletableFuture<U>
- supplyAsync(Supplier<U>,Executor):CompletableFuture<U>
- runAsync(Runnable):CompletableFuture<Void>
- 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>

See www.educative.io/answers/what-is-completablefuturejoin-in-java

Basic CompletableFuture Features

- Basic CompletableFuture features
  - Support the Future API
  - Define a join() method
    - Blocks awaiting results
    - Behaves like get() *without* using checked exceptions

```
futures
   .stream()
   .map(CompletableFuture
        ::join)
   .collect(toList())
```



CompletableFuture::join can be used as a method reference in a Java stream

See www.javaadvent.com/2020/12/exceptions-and-streams.html

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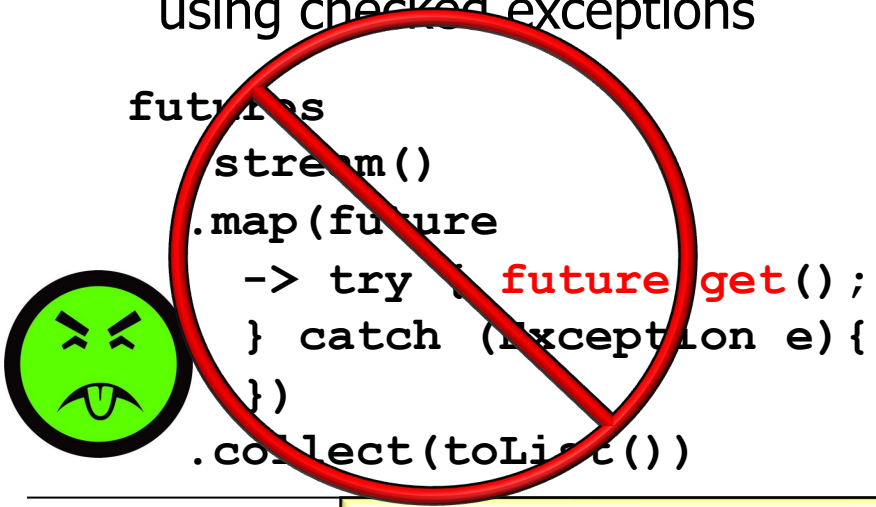

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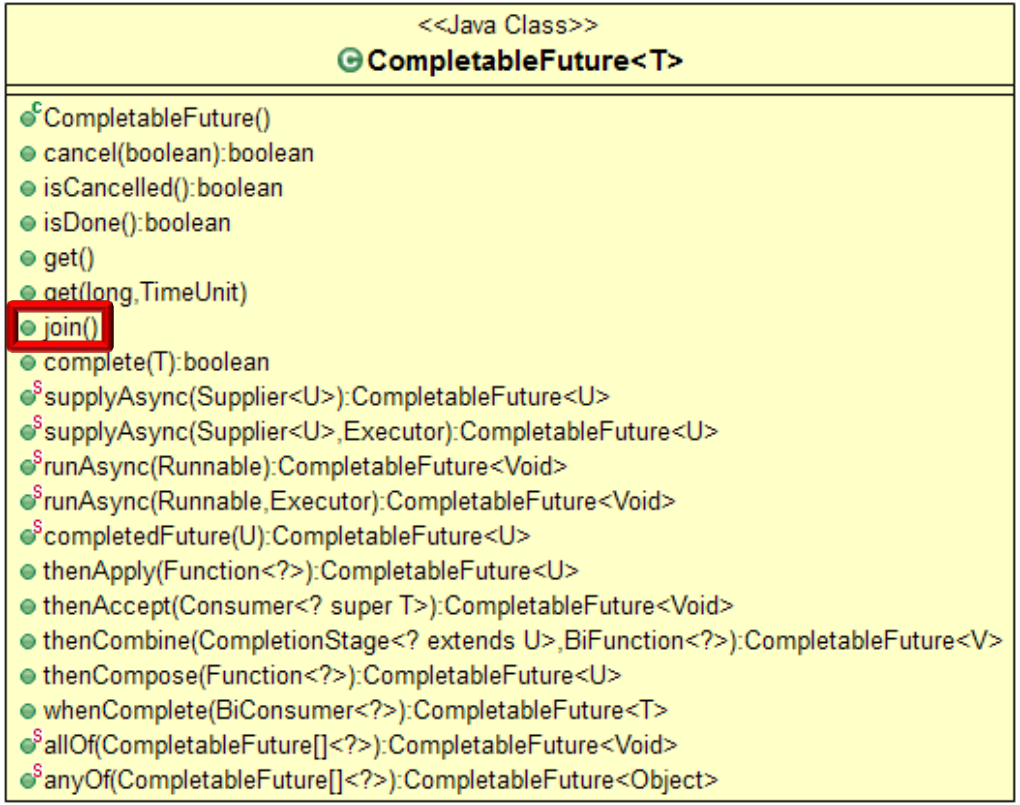
Mixing checked exceptions & Java streams is ugly..

Basic CompletableFuture Features

- Basic CompletableFuture features
  - Support the Future API
  - Define a join() method
    - Blocks awaiting results
    - Behaves like get() *without* using checked exceptions

```
futures
   .stream()
   .map(f -> rethrowSupplier
     (f::get).get())
   .collect(toList())
```



Exception laundering is also an option, but may be overkill compared with join()

See stackoverflow.com/a/27644392/3312330

Basic CompletableFuture Features

- Basic CompletableFuture features
  - Support the Future API
  - Define a join() method
    - Blocks awaiting results
    - Behaves like get() *without* using checked exceptions
    - There is no timed version of join()

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See tedblob.com/completablefuture-join-vs-get

Basic CompletableFuture Features

- Basic CompletableFuture features
  - Support the Future API
  - Define a join() method
  - Can be completed explicitly

you complete me

<<Java Class>>
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- allOf(CompletableFuture[]<?>):CompletableFuture<Void>
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See docs.oracle.com/javase/8/docs/api/java/util/concurrent/CompletableFuture.html#complete

Basic CompletableFuture Features

- Basic CompletableFuture features
  - Support the Future API
  - Define a join() method
  - Can be completed explicitly
    - i.e., sets future result to a given value, which is then returned by get()/join()

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


...


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

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

Basic CompletableFuture Features

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  - Define a join() method
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```
CompletableFuture<...> future =
  new CompletableFuture<>();
...

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

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

First create an incomplete future

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

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  - Define a join() method
  - Can be completed explicitly
    - i.e., sets future result to a given value, which is then returned by get()/join()

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

...

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

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

Create/start a new thread that runs concurrently with the calling thread

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

Basic CompletableFuture Features

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  - Support the Future API
  - Define a join() method
  - Can be completed explicitly
    - i.e., sets future result to a given value, which is then returned by get()/join()

you complete me

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

...

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

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

After complete() is done calls to join() will unblock

See docs.oracle.com/javase/8/docs/api/java/util/concurrent/CompletableFuture.html#complete

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- Basic CompletableFuture features
  - Support the Future API
  - Define a join() method
  - Can be completed explicitly
    - i.e., sets future result to a given value, which is then returned by get()/join()

A completable future can be initialized to a value/constant

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

CompletableFuture<Long> zero
  = CompletableFuture
      .completedFuture(0L);

new Thread (() -> {
  ...
  future.complete(zero.join());
}).start();

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

See docs.oracle.com/javase/8/docs/api/java/util/concurrent/CompletableFuture.html#completedFuture

End of Overview of Basic Java CompletableFuture Features