Advanced Java CompletableFuture Features: Introducing Completion Stage Methods (Part 1)

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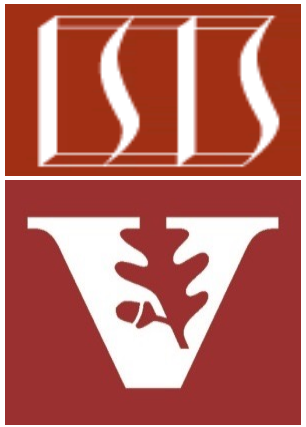

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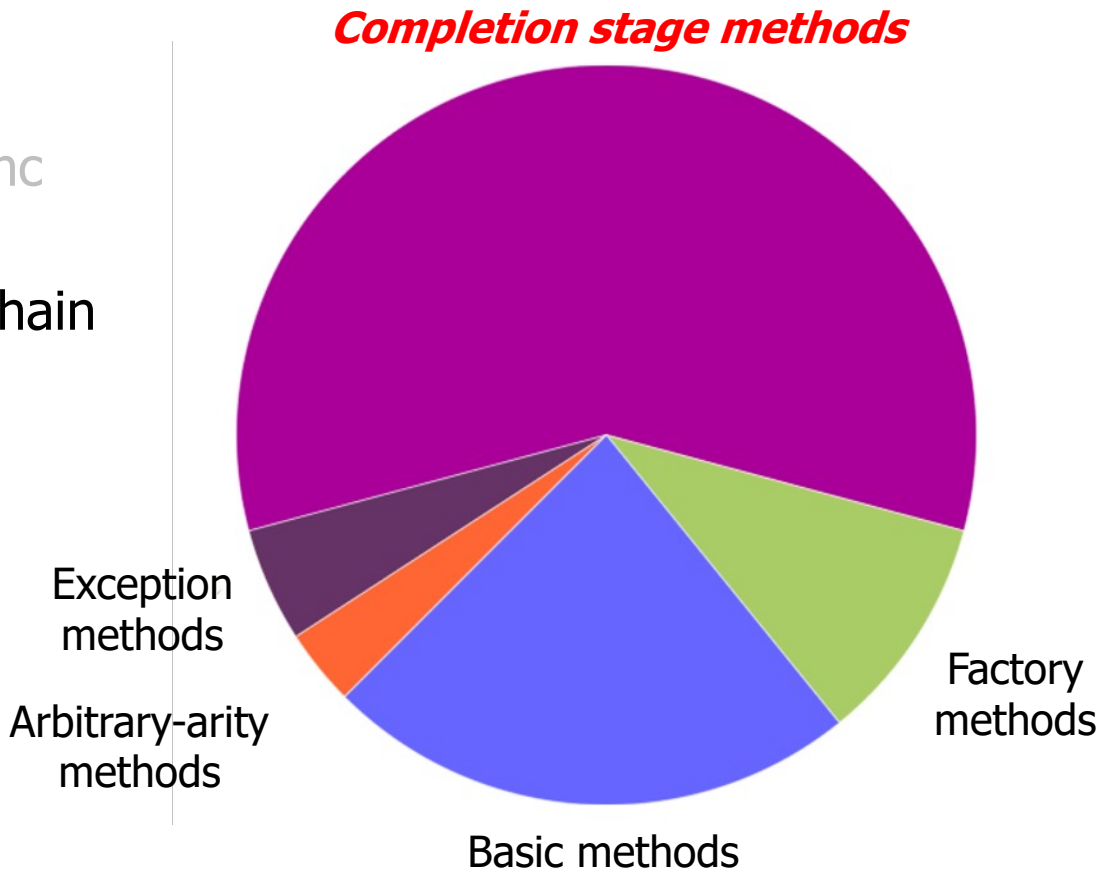
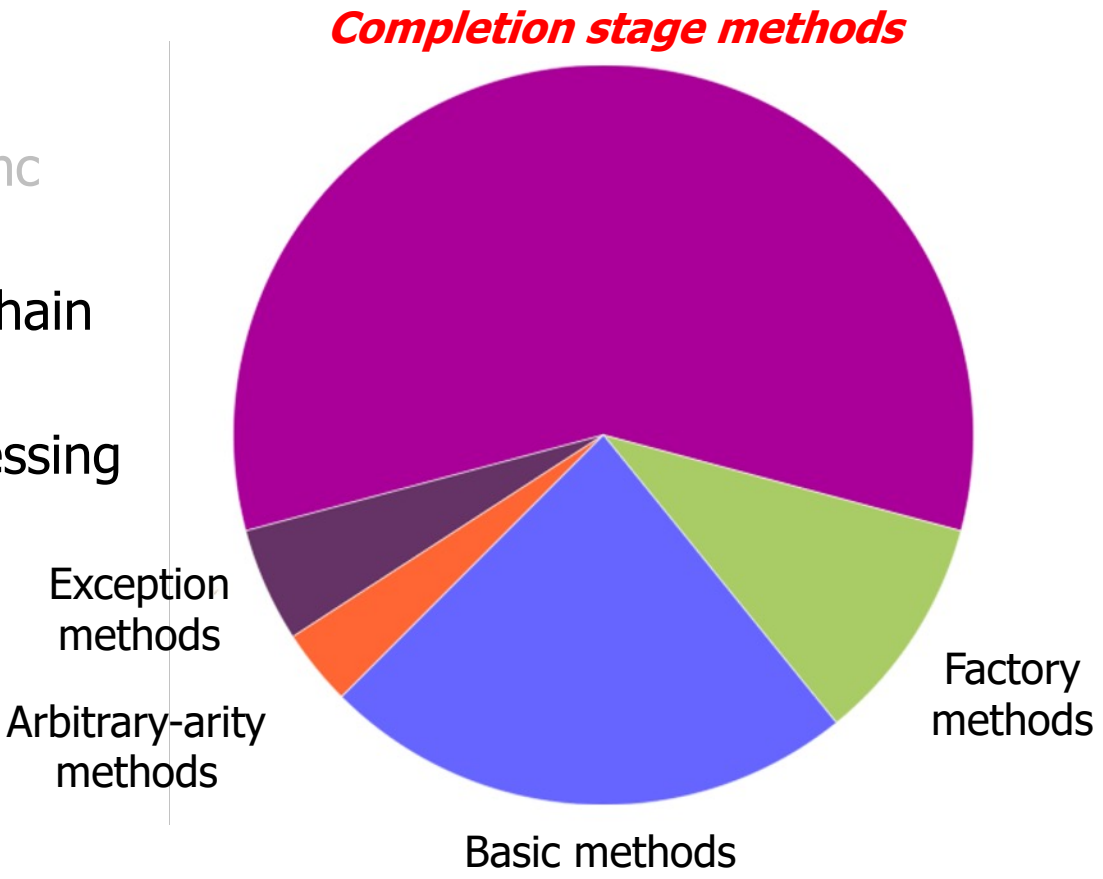
Learning Objectives in this Part of the Lesson

- Understand advanced features of completable futures, e.g.
  - Factory methods initiate async computations
  - Completion stage methods chain together dependent actions



Learning Objectives in this Part of the Lesson

- Understand advanced features of completable futures, e.g.
  - Factory methods initiate async computations
  - Completion stage methods chain together dependent actions
    - Perform async result processing & composition



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

Overview of Completion Stages

Overview of Completion Stages

- A completable future can serve as a ”completion stage” for async result processing

Interface CompletionStage<T>

All Known Implementing Classes:

`CompletableFuture`

`public interface CompletionStage<T>`

A stage of a possibly asynchronous computation, that performs an action or computes a value when another CompletionStage completes. A stage completes upon termination of its computation, but this may in turn trigger other dependent stages. The functionality defined in this interface takes only a few basic forms, which expand out to a larger set of methods to capture a range of usage styles:

- The computation performed by a stage may be expressed as a Function, Consumer, or Runnable (using methods with names including *apply*, *accept*, or *run*, respectively) depending on whether it requires arguments and/or produces results. For example, `stage.thenApply(x -> square(x)).thenAccept(x -> System.out.print(x)).thenRun(() -> System.out.println())`. An additional form (*compose*) applies functions of stages themselves, rather than their results.
- One stage's execution may be triggered by completion of a single stage, or both of two stages, or either of two stages. Dependencies on a single stage are arranged using methods with prefix *then*. Those triggered by completion of *both* of two stages may *combine* their results or effects, using correspondingly named methods. Those triggered by *either* of two stages make no guarantees about which of the results or effects are used for the dependent stage's computation.

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Overview of Completion Stages

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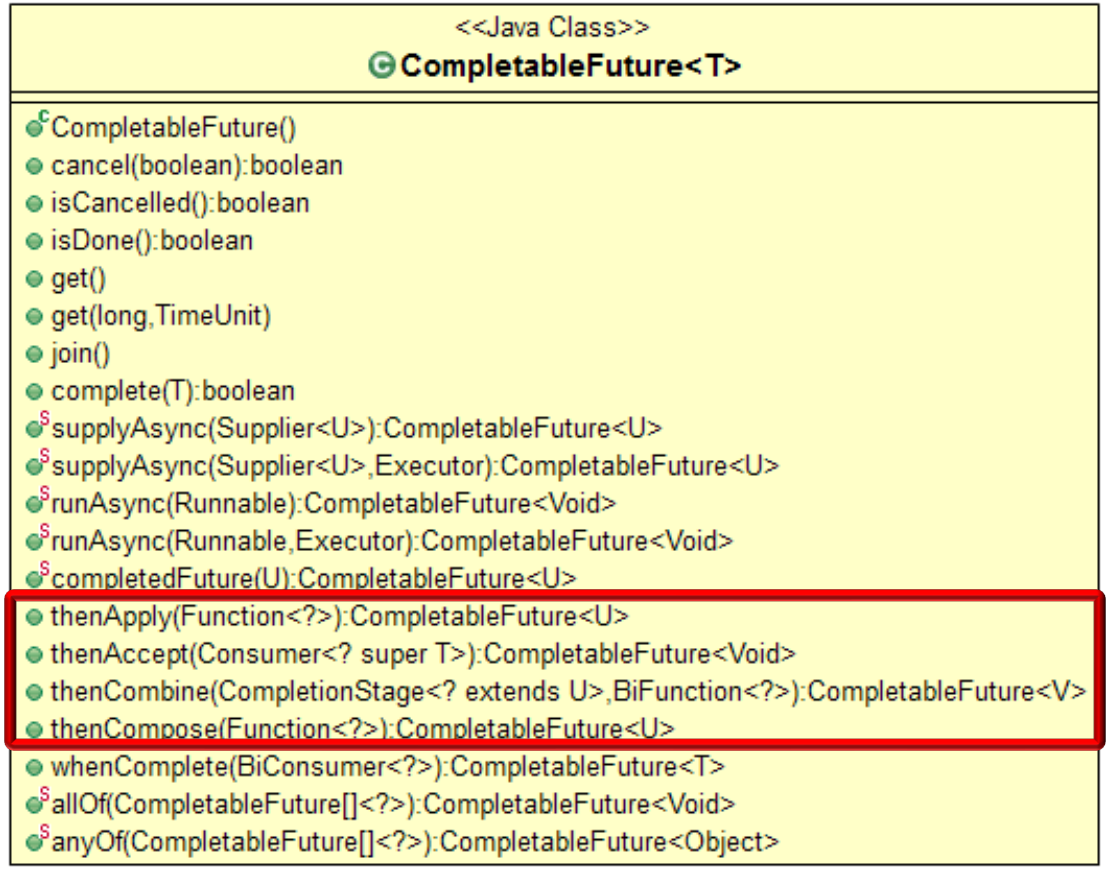
  - Performs an action or computes a value when another CompletionStage completes



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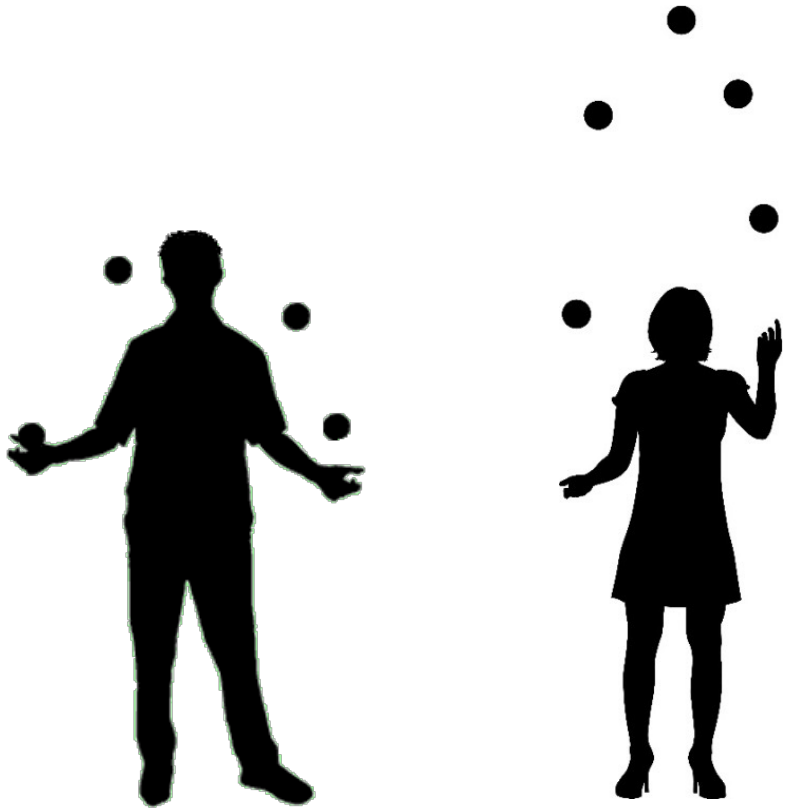
Overview of Completion Stages

- A completable future can serve as a ”completion stage” for async result processing
  - Performs an action or computes a value when another CompletionStage completes
  - Juggling is a good analogy for completion stages!



See en.wikipedia.org/wiki/Juggling

Overview of Completion Stages

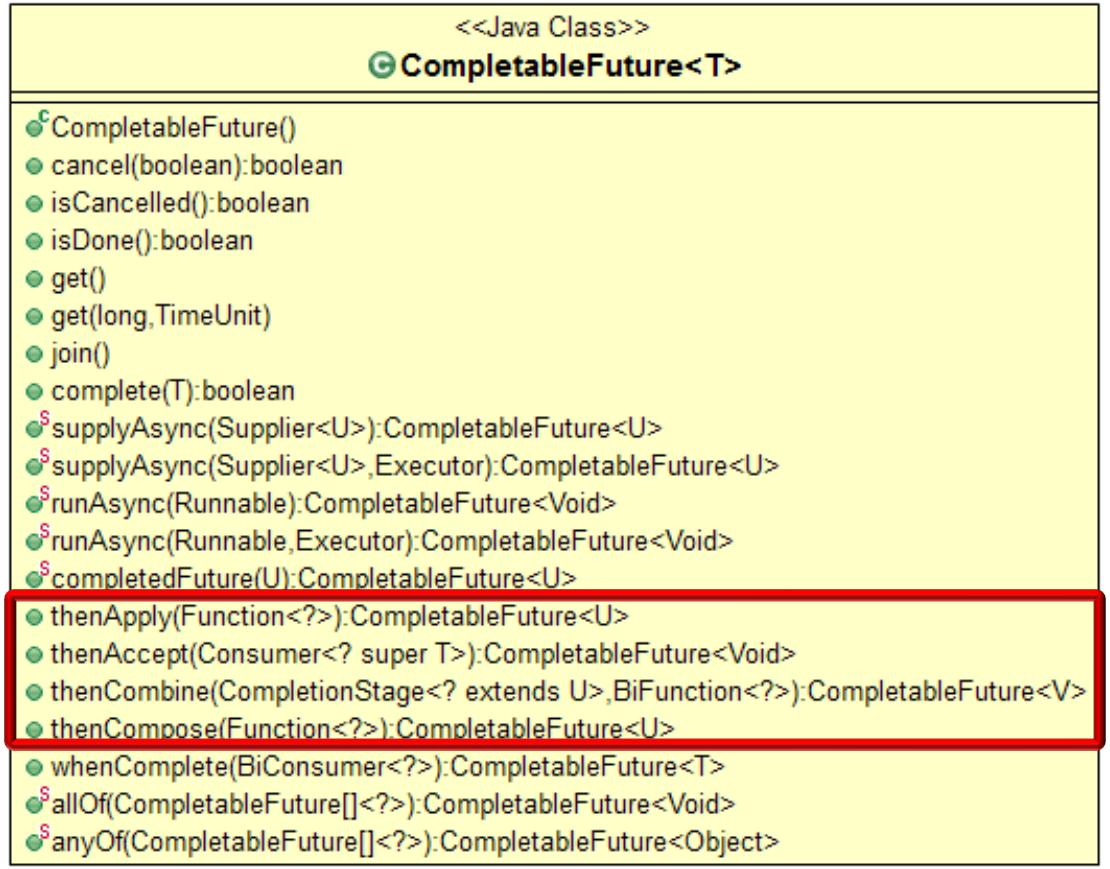
- A completable future can serve as a ”completion stage” for async result processing
  - Performs an action or computes a value when another CompletionStage completes
  - Juggling is a good analogy for completion stages!
  - Resources are only consumed when an action runs, which reduces system overhead

See en.wikipedia.org/wiki/Start-stop_system

Chaining Actions Together via Completion Stage Methods

Chaining Actions Together via Completion Stage Methods

- Completable futures can be chained together via completion stage methods



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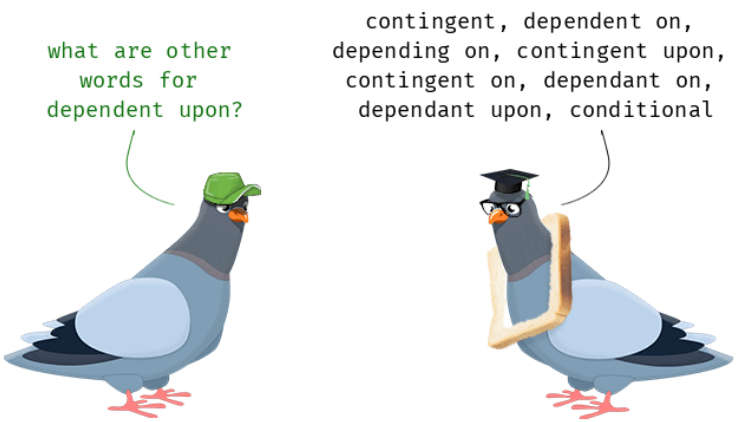
Chaining Actions Together via Completion Stage Methods

- Completable futures can be chained together via completion stage methods
  - A dependent action handles the result after a previous async call completes




```
BigFraction unreduced = BigFraction
   .valueOf(new BigInteger
                ("8461225360066988 2"),
            new BigInteger
                ("18802723413348 2196"),
            false); // Don't reduce!

Supplier<BigFraction> reduce = () ->
  BigFraction.reduce(unreduced);

CompletableFuture
   .supplyAsync(reduce)
   .thenApply(BigFraction
                ::toMixedString)
   ...
```

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

Chaining Actions Together via Completion Stage Methods

- Completable futures can be chained together via completion stage methods
  - A dependent action handles the result after a previous async call completes

Create an unreduced big fraction variable

```
BigFraction unreduced = BigFraction
   .valueOf(new BigInteger
                ("8461225536006698 82"),
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```

See math.answers.com/questions/What_is_an_unreduced_fraction

Chaining Actions Together via Completion Stage Methods

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```
BigFraction unreduced = BigFraction
   .valueOf(new BigInteger
                ("84612255360669882"),
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            false); // Don't reduce!

Supplier<BigFraction> reduce = () ->
   BigFraction.reduce(unreduced);

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```

Create a supplier lambda variable that will reduce the big fraction

See docs.oracle.com/javase/8/docs/api/java/util/function/Supplier.html

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This factory method will asynchronously reduce the big fraction supplier lambda

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

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```

thenApply()'s action is triggered when future from supplyAsync() completes

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

Chaining Actions Together via Completion Stage Methods

- Completable futures can be chained together via completion stage methods
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- Methods can be chained together "fluently"

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   .thenAccept(System.out::println);
```

See en.wikipedia.org/wiki/Fluent_interface

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thenAccept()'s action is triggered when future from thenApply() completes

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

Chaining Actions Together via Completion Stage Methods

- Completable futures can be chained together via completion stage methods
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- Methods can be chained together "fluently"
  - Each method registers an action to apply

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  - A dependent action handles the result after a previous async call completes
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  - A lambda action is called only after previous stage completes successfully

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This is what is meant by "chaining" via the *Fluent Interface* pattern

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```

Action is "deferred" until previous stage completes & a fork-join thread is available

Chaining Actions Together via Completion Stage Methods

- Completable futures can be chained together via completion stage methods
  - A dependent action handles the result after a previous async call completes
  - Methods can be chained together "fluently"
  - Fluent chaining enables async programming to look like sync programming

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End of Advanced Java CompletableFuture Features: Introducing Completion Stage Methods (Part 1)