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

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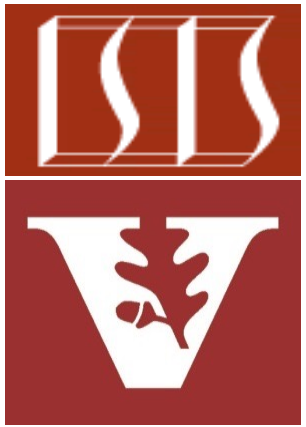

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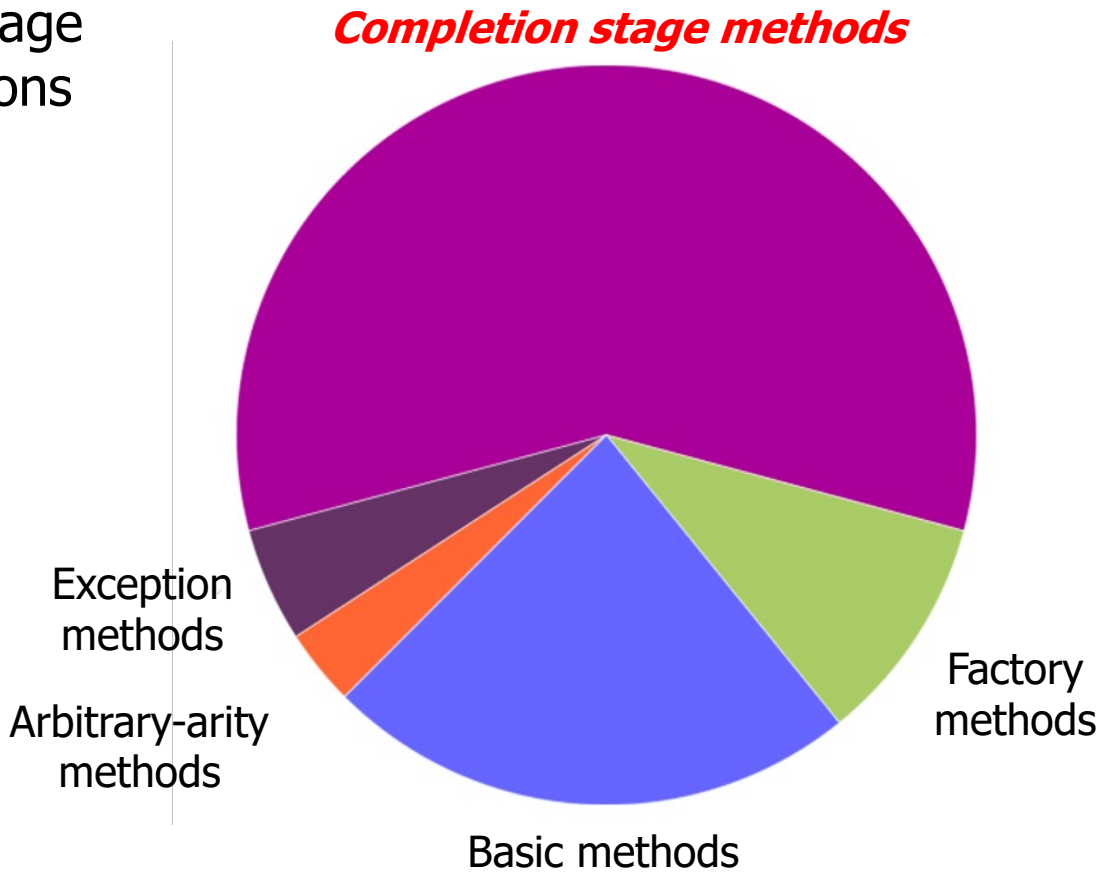
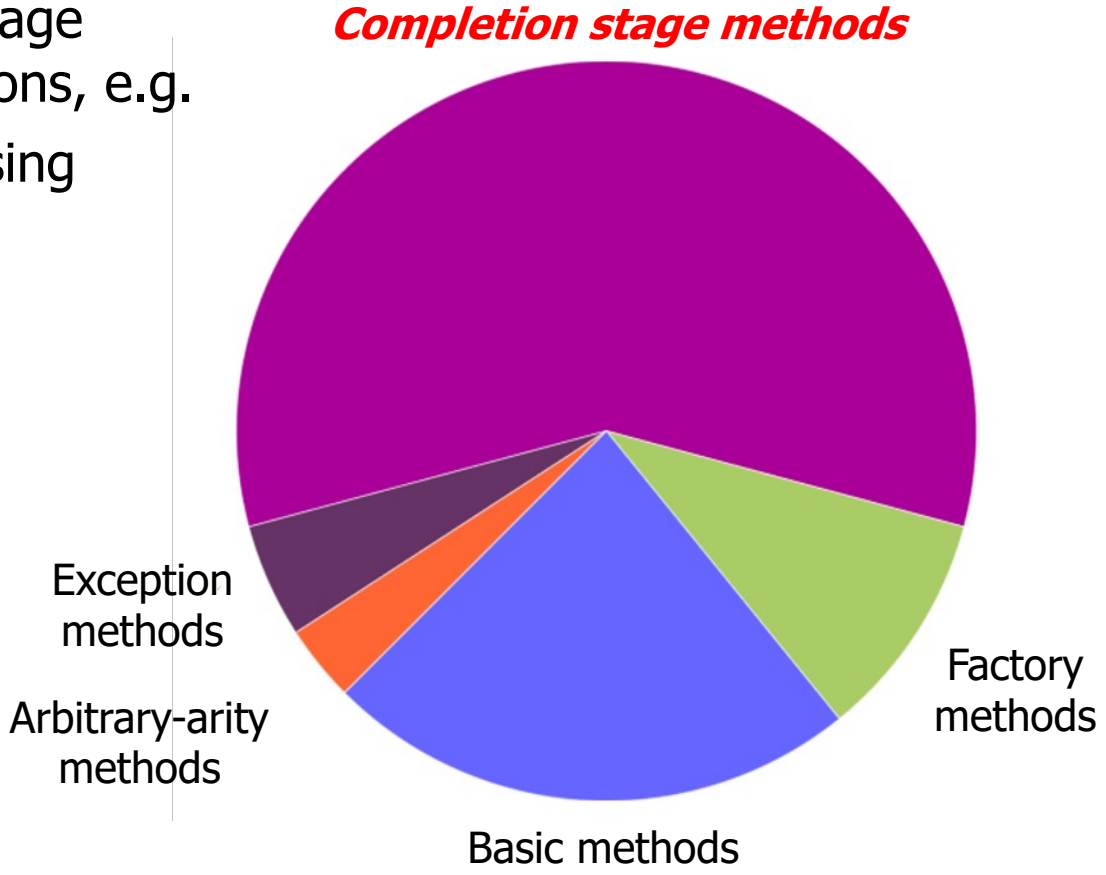
Learning Objectives in this Part of the Lesson

- Understand how completion stage methods chain dependent actions



Learning Objectives in this Part of the Lesson

- Understand how completion stage methods chain dependent actions, e.g.
  - 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>
```

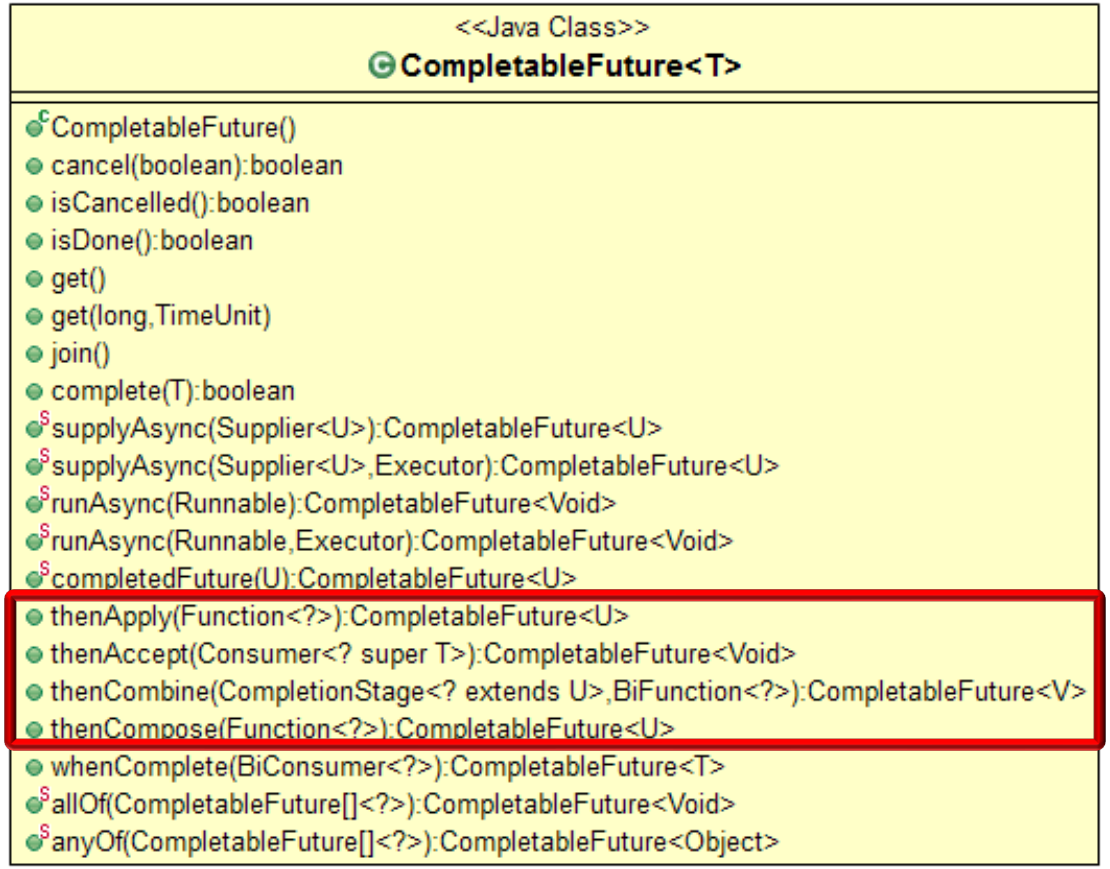
A stage of a possibly asynchronous computation, that performs an action or computes a value when another CompletionStage completes. A stage completes upon termination of its computation, but this may in turn trigger other dependent stages. The functionality defined in this interface takes only a few 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.

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

Overview of Completion Stages

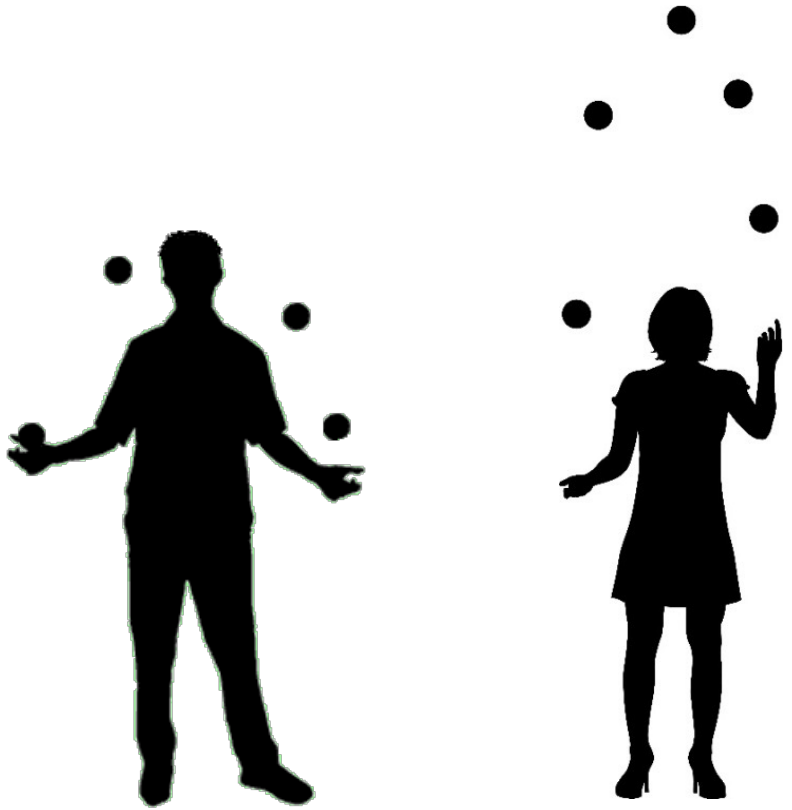
- A completable future can serve as a "completion stage" for async result processing
  - Performs an action or computes a value when another CompletionStage completes



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

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

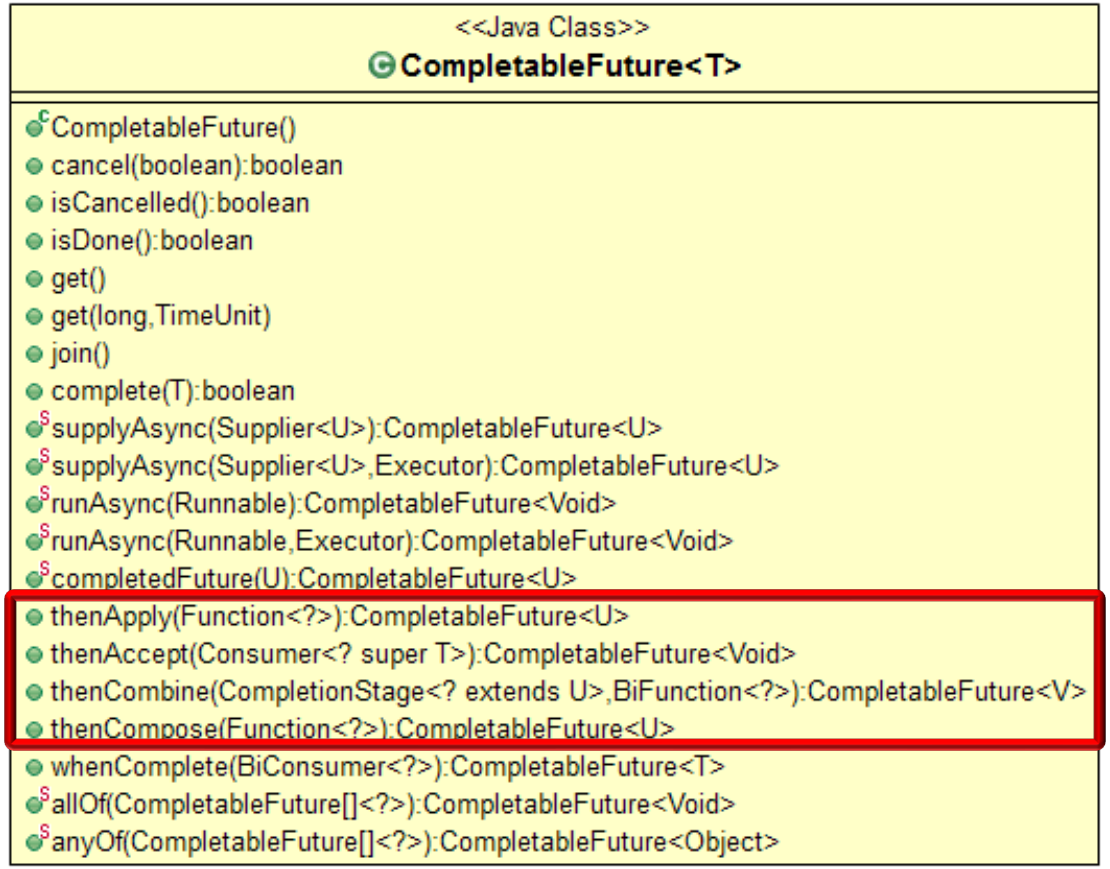
- A completable future can serve as a ”completion stage” for async result processing
  - Performs an action or computes a value when another CompletionStage completes
  - Juggling is a good analogy for completion stages!
  - Processing resources are only consumed when an action runs
    - This reduces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

<<Java Class>>

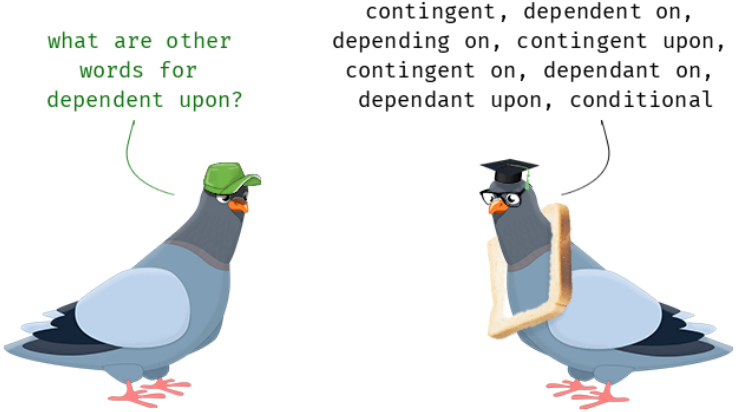
CompletableFuture<T>

- 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>

Help make programs more *responsive* by not blocking caller code

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
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Create an unreduced big fraction variable

```
BigFraction unreduced = BigFraction
   .valueOf(new BigInteger
                ("8461225536006698 82"),
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Supplier<BigFraction> reduce = () ->
  BigFraction.reduce(unreduced);

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```

See math.answers.com/questions/What_is_an_unreduced_fraction

Chaining Actions Together via Completion Stage Methods

- Completable futures can be chained together via completion stage methods
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```
BigFraction unreduced = BigFraction
   .valueOf(new BigInteger
                ("84612255360669882"),
            new BigInteger
                ("18802723413348219 6"),
            false); // Don't reduce!

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

CompletableFuture
   .supplyAsync(reduce)
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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
  - A dependent action handles the result after a previous async call completes
- Methods can be chained together "fluently"

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

See en.wikipedia.org/wiki/Fluent_interface

Chaining Actions Together via Completion Stage Methods

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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
  - A dependent action handles the result after a previous async call completes
- Methods can be chained together "fluently"
  - Each method registers an action to apply

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- 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"
  - Each method registers an action to apply
  - An action is called only after the 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)