Overview of Advanced Java 8 CompletableFuture Features (Part 4)

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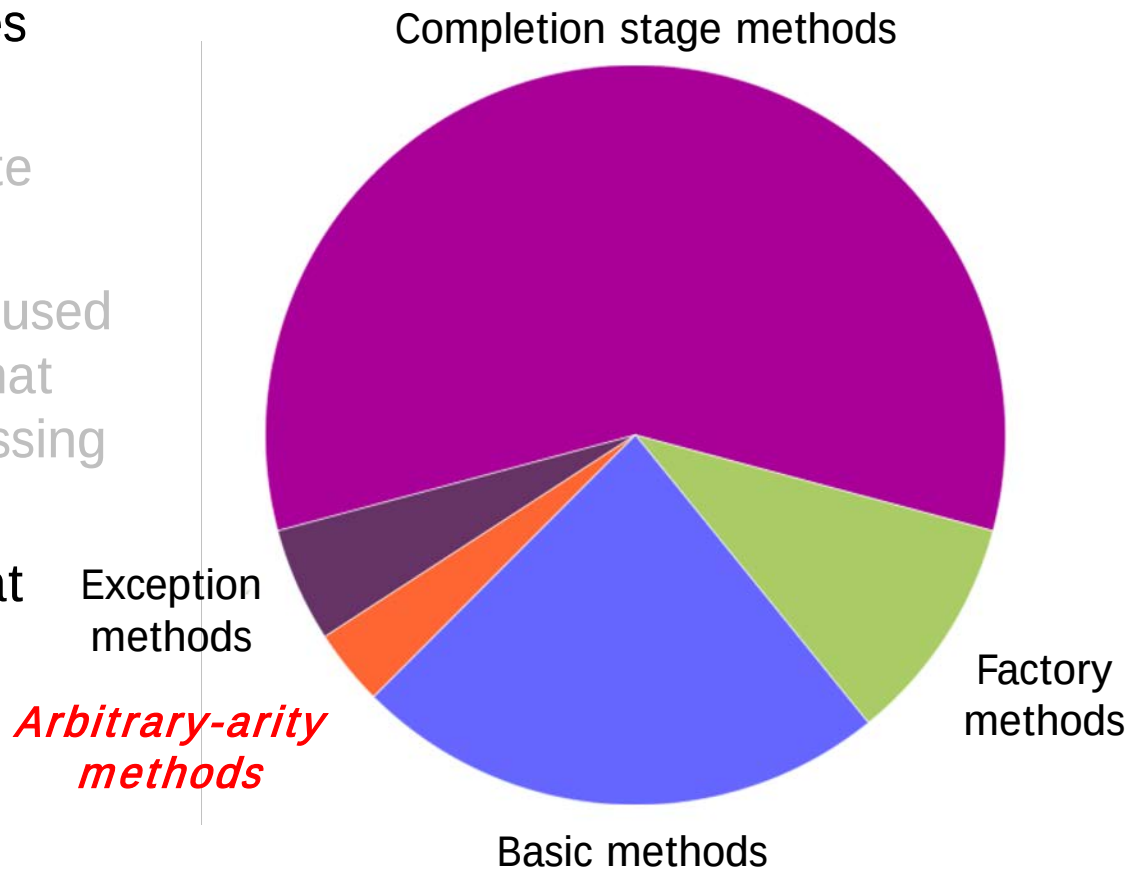
Learning Objectives in this Part of the Lesson

- Understand advanced features of completable futures, e.g.
  - Factory methods that initiate async functionality
  - Completion stage methods used to chain together actions that perform async result processing & composition
  - Aribitrary-arity methods that process futures in bulk



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

Arbitrary-Arity Methods Process Futures in Bulk

Arbitrary-Arity Methods Process Futures in Bulk

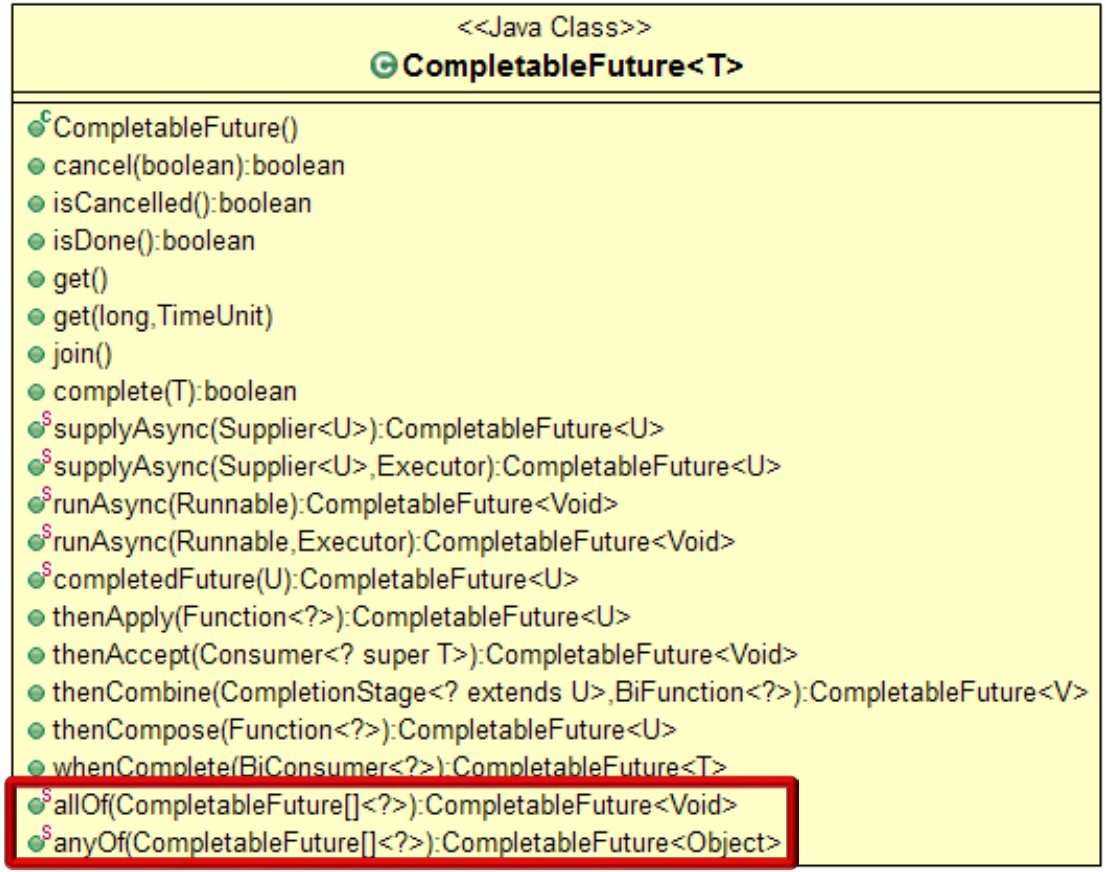
- Arbitrary-arity methods are triggered after completion of some/all of *n* futures

Methods	Params	Returns	Behavior
allOf	Varags	Completable Future<Void>	Return a future that completes when all futures in params complete
anyOf	Varargs	Completable Future<Void>	Return a future that completes when any future in params complete

These “arbitrary-arity” methods are hard to program without using wrappers

Arbitrary-Arity Methods Process Futures in Bulk

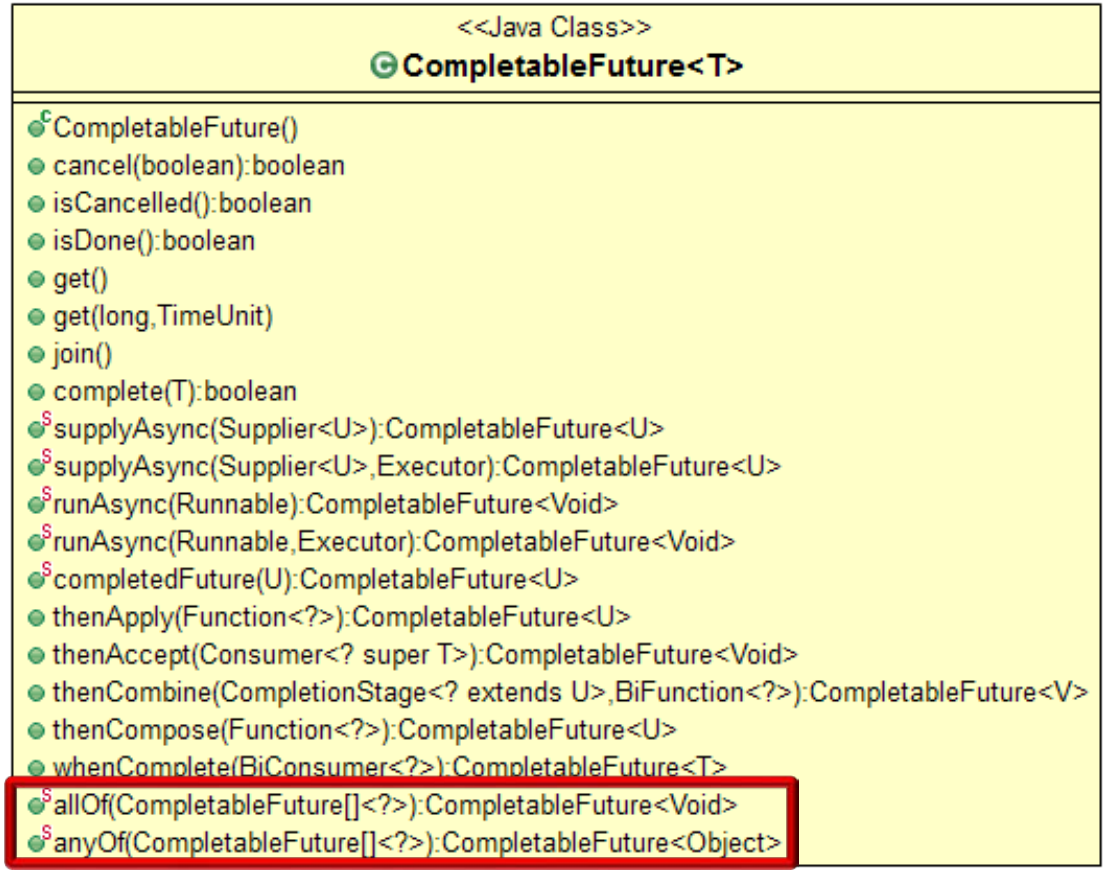
- Arbitrary-arity methods are triggered after completion of some/all of *n* futures



See en.wikipedia.org/wiki/Arity

Arbitrary-Arity Methods Process Futures in Bulk

- Arbitrary-arity methods are triggered after completion of some/all of *n* futures
  - Can wait for any or all completable futures in an array to complete



Arbitrary-Arity Methods Process Futures in Bulk

- Arbitrary-arity methods are triggered after completion of some/all of *n* futures
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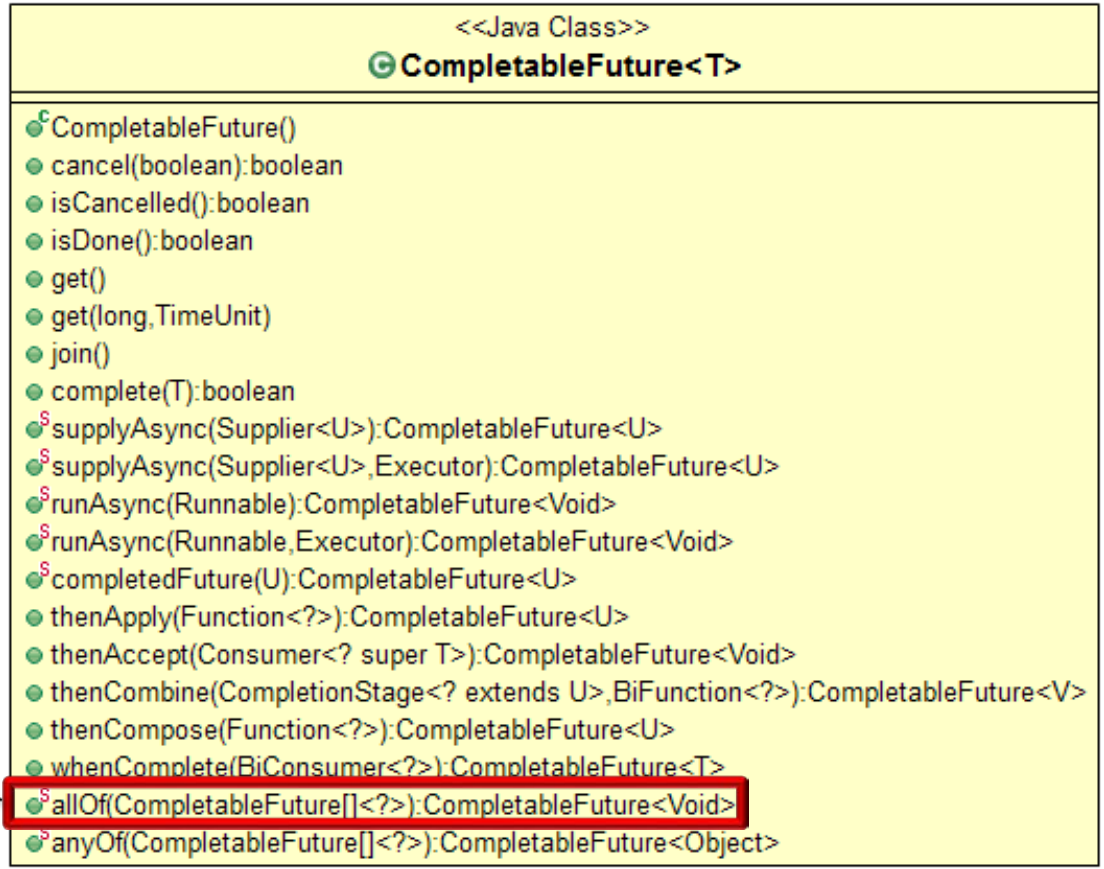
We focus on allOf()



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

Arbitrary-Arity Methods Process Futures in Bulk

- FuturesCollector is used to return a completable future to a list of big fractions that are being reduced and multiplied asynchronously

```
static void testFractionMultiplications() {
  ...
  Stream.generate(() -> makeBigFraction(new Random(), false))

        .limit(sMAX_FRACTIONS)

        .map(reduceAndMultiplyFraction)

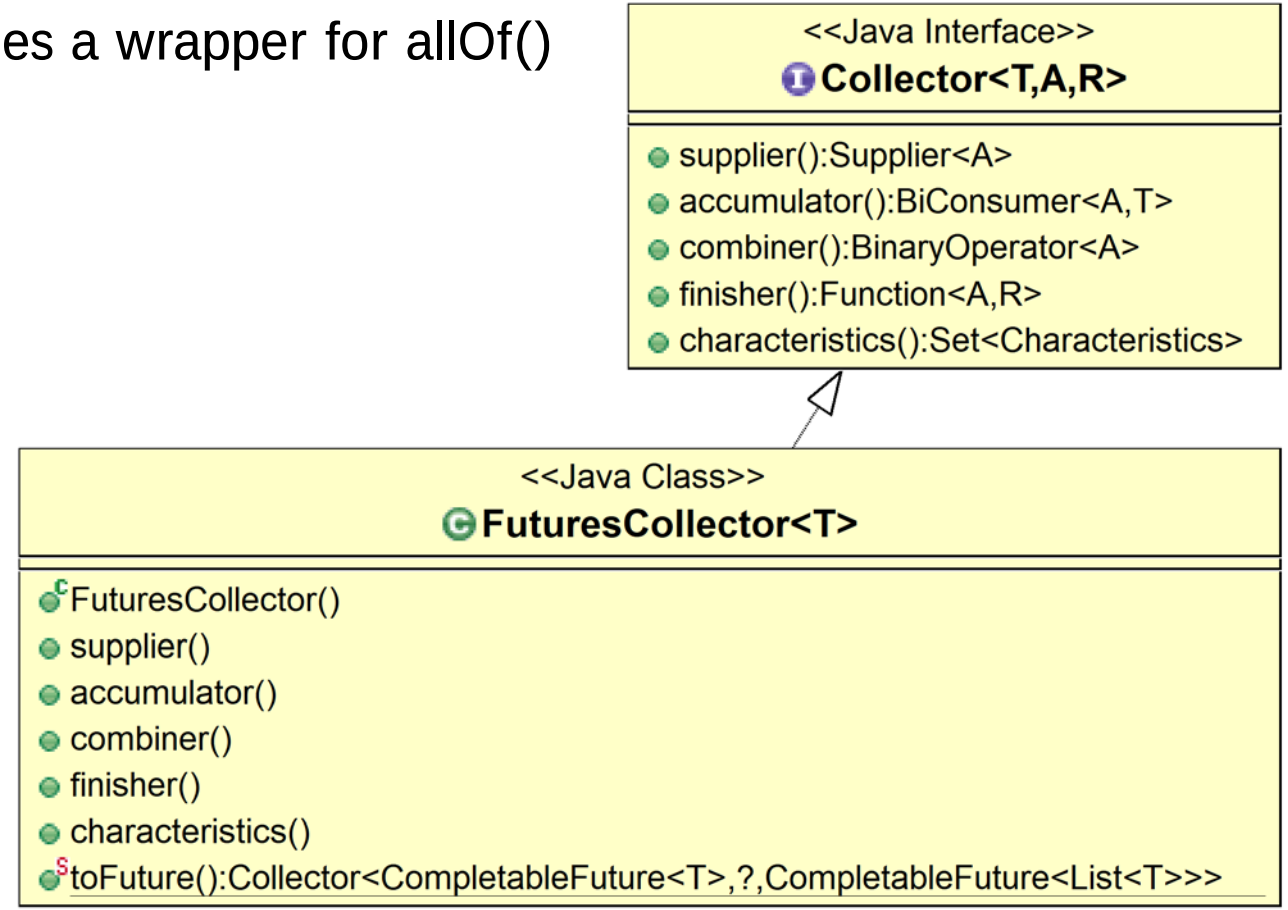
        .collect(FuturesCollector.toFuture())

        .thenAccept(printSortedList);
}
```

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

Arbitrary-Arity Methods Process Futures in Bulk

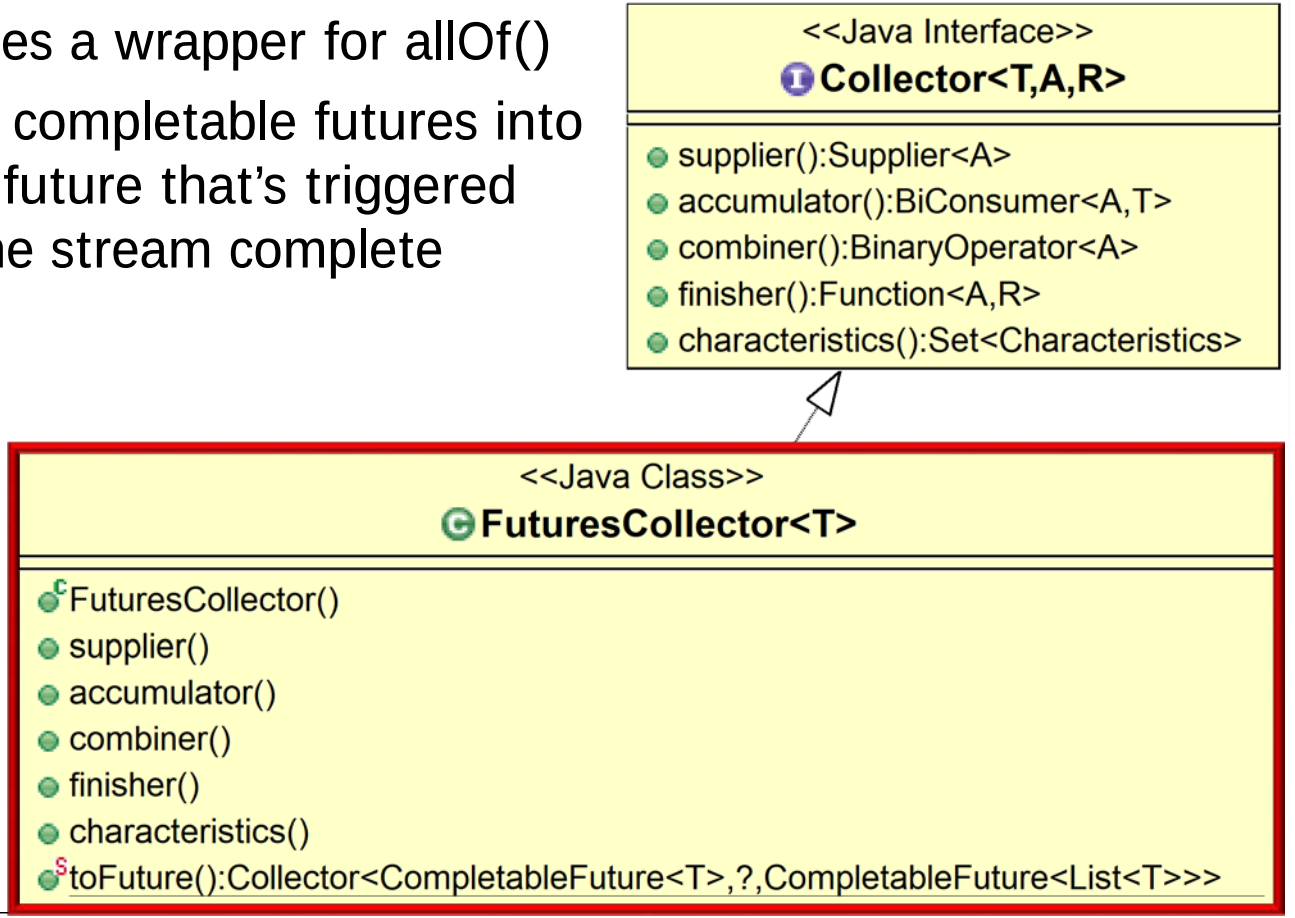
- FuturesCollector provides a wrapper for allOf()



See Java8/ex8/utils/FuturesCollector.java

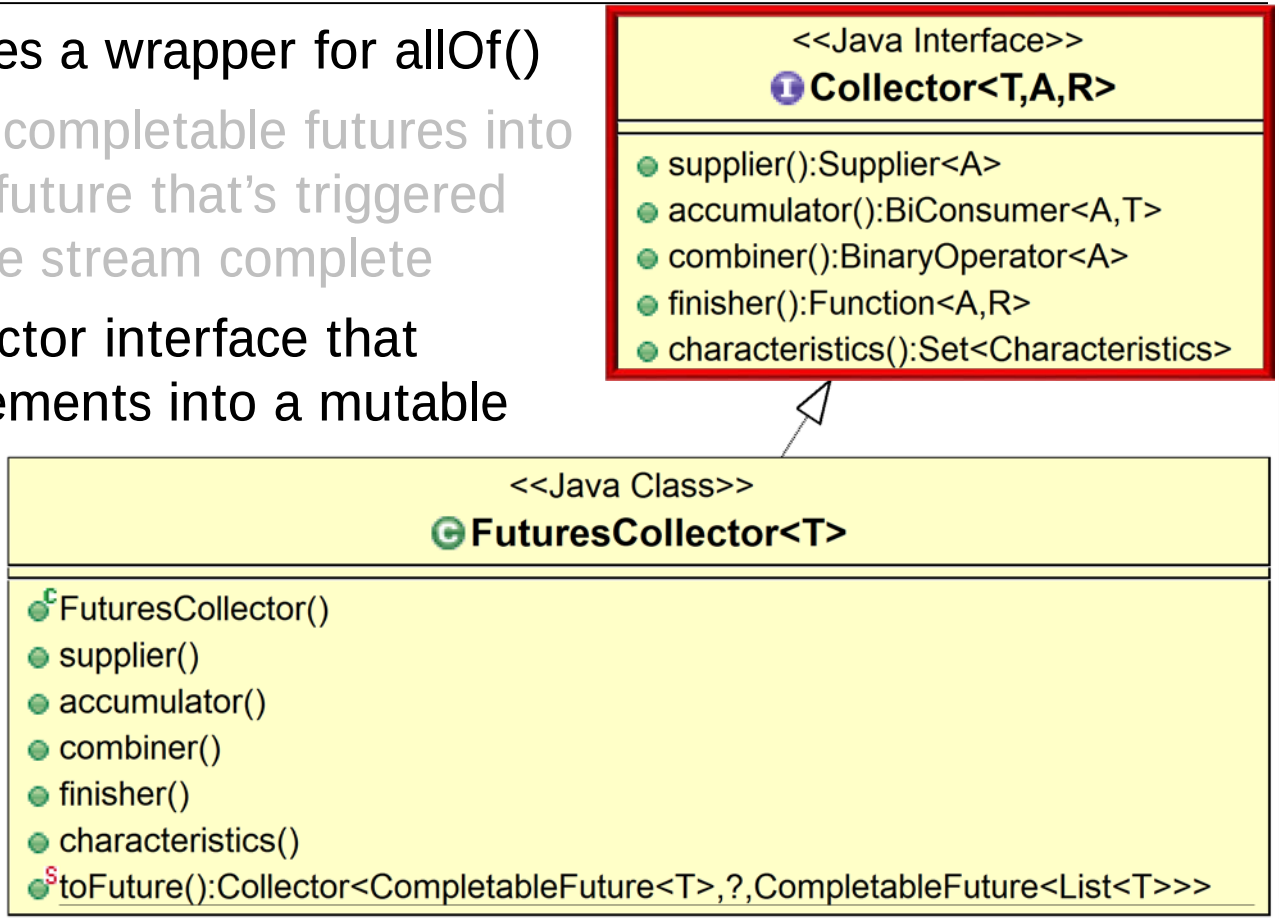
Arbitrary-Arity Methods Process Futures in Bulk

- FuturesCollector provides a wrapper for allOf()
  - Converts a *stream* of completable futures into a *single* completable future that's triggered when *all* futures in the stream complete



Arbitrary-Arity Methods Process Futures in Bulk

- FuturesCollector provides a wrapper for allOf()
  - Converts a *stream* of completable futures into a *single* completable future that's triggered when *all* futures in the stream complete
  - Implements the Collector interface that accumulates input elements into a mutable result container



See docs.oracle.com/javase/8/docs/api/java/util/stream/Collector.html

Arbitrary-Arity Methods Process Futures in Bulk

- FuturesCollector provides a wrapper for allOf()

<<Java Interface>>
Collector<T,A,R>

- supplier():Supplier<A>
- accumulator():BiConsumer<A,T>
- combiner():BinaryOperator<A>
- finisher():Function<A,R>
- characteristics():Set<Characteristics>

<<Java Class>>
FuturesCollector<T>

- FuturesCollector()
- supplier()
- accumulator()
- combiner()
- finisher()
- characteristics()
- toFuture():Collector<CompletableFuture<T>,?,CompletableFuture<List<T>>>

FuturesCollector provides a powerful wrapper for some complex code!!!

Arbitrary-Arity Methods Process Futures in Bulk

- FuturesCollector provides a wrapper for allOf()

```
public class FuturesCollector<T>
       implements Collector<CompletableFuture<T>,
                            List<CompletableFuture<T>>,
                            CompletableFuture<List<T>>> {
  ...
```

Implements a custom collector

See docs.oracle.com/javase/8/docs/api/java/util/stream/Collector.html

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  ...
```

The type of input elements to the accumulator() method

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  ...
```

The mutable accumulation type of the accumulator() method

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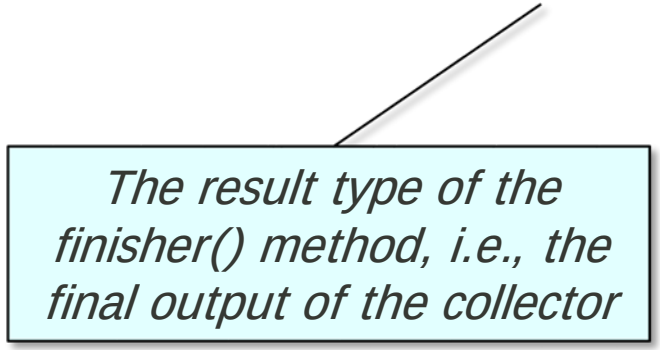

Arbitrary-Arity Methods Process Futures in Bulk

- FuturesCollector provides a wrapper for allOf()

```
public class FuturesCollector<T>
       implements Collector<CompletableFuture<T>,
                            List<CompletableFuture<T>>,
                            CompletableFuture<List<T>>> {
  public Supplier<List<CompletableFuture<T>>> supplier() {
    return ArrayList::new;
  }

  public BiConsumer<List<CompletableFuture<T>>,
                    CompletableFuture<T>> accumulator() {
    return List::add;
  }
  ...
```

Factory method that creates & returns a new mutable array list container

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    return ArrayList::new;
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  public BiConsumer<List<CompletableFuture<T>>,
                    CompletableFuture<T>> accumulator() {
    return List::add;
  }
  ...
```

Folds a new completable future into the mutable array list container

Arbitrary-Arity Methods Process Futures in Bulk

- FuturesCollector provides a wrapper for allOf()

```
public class FuturesCollector<T>
  ...
  public BinaryOperator<List<CompletableFuture<T>>> combiner() {
    return (List<CompletableFuture<T>> one,
            List<CompletableFuture<T>> another) -> {
        one.addAll(another);
        return one;
    };
  }
  ...
```

Accepts two partial array list results & merges them into a single array list

Arbitrary-Arity Methods Process Futures in Bulk

- FuturesCollector provides a wrapper for allOf()

```
public class FuturesCollector<T>
  ...
  public Function<List<CompletableFuture<T>>,
                  CompletableFuture<List<T>>> finisher() {
    return futures -> CompletableFuture
      .allOf(futures.toArray(new CompletableFuture[0]))
      .thenApply(v -> futures.stream()
                             .map(CompletableFuture::join)
                             .collect(toList()));
  }
  ...
```

Perform final transformation from the intermediate array list accumulation type to the final completable future result type

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  }
  ...
```

Convert list of futures to array of futures & pass to allOf() to obtain a future that will complete when all futures complete

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  }
  ...
```

When all futures have completed get a single future to a list of joined elements of type T

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  }
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```

This call to join() will never block!

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  }
  ...
```

Return a future to a list of elements of T

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```
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  ...
  Stream.generate(() -> makeBigFraction(new Random(), false))

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Arbitrary-Arity Methods Process Futures in Bulk

- FuturesCollector provides a wrapper for allOf()

```
public class FuturesCollector<T>
  ...
  public Set characteristics() {
    return Collections.singleton(Characteristics.UNORDERED);
  }



  public static <T> Collector<CompletableFuture<T>, ?,
                              CompletableFuture<List<T>>>
  toFuture() {
    return new FuturesCollector<>();
  }
}
```

Returns a set indicating the characteristics of FutureCollector

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  toFuture() {
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```

Static factory method creates a new FuturesCollector

End of Overview of Advanced Java 8 Completable Future Features (Part 4)