# Advanced Java CompletableFuture Features: Implementing FuturesCollector


Douglas C. Schmidt

d.schmidt@vanderbilt.edu

www.dre.vanderbilt.edu/~schmidt

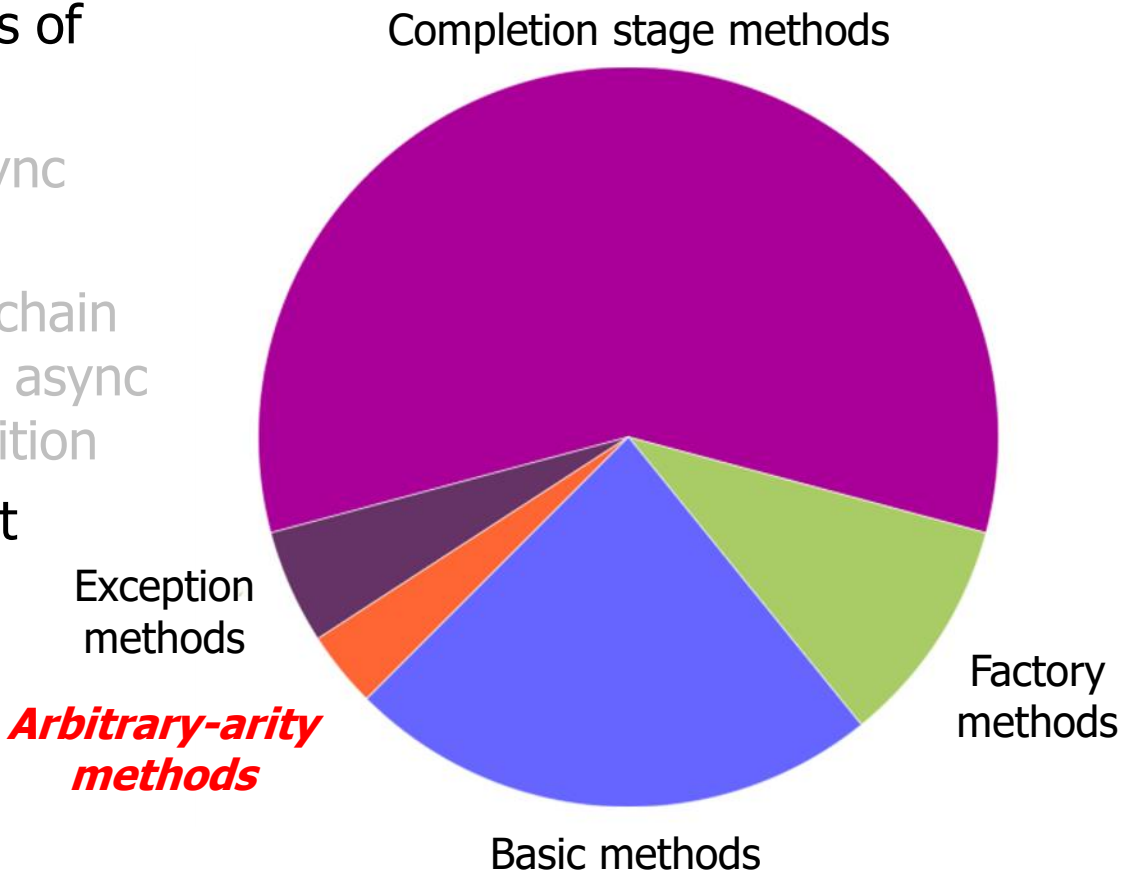
Professor of Computer Science

Institute for Software Integrated Systems

Vanderbilt University
Nashville, Tennessee, USA


# 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 actions to perform async result processing & composition
  - Aribitrary-arity methods that process futures in bulk
    - Provide a wrapper for the allOf() method




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

# Implementing the FuturesCollector Class

# Implementing the FuturesCollector Class

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

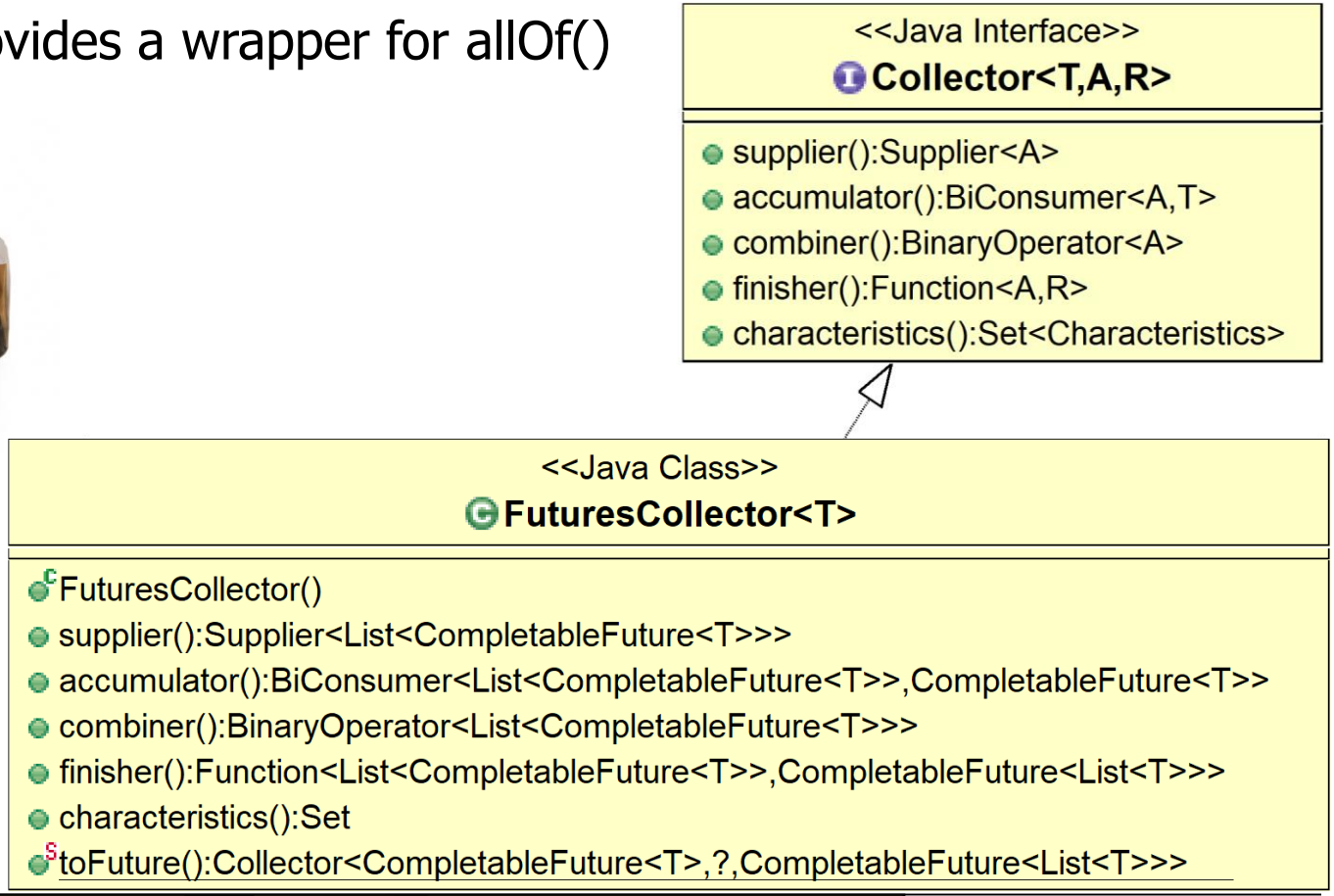
```
static void testFractionMultiplications1() {
   ...
   Stream.generate(() -> makeBigFraction(new Random(), false))

         .limit(sMAX_FRACTIONS)

         .map(reduceAndMultiplyFractions)

         .collect(FuturesCollector.toFuture())

         .thenAccept(this::sortAndPrintList);
}
```

*collect() converts a stream of completable futures into a single completable future*

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

# Implementing the FuturesCollector Class

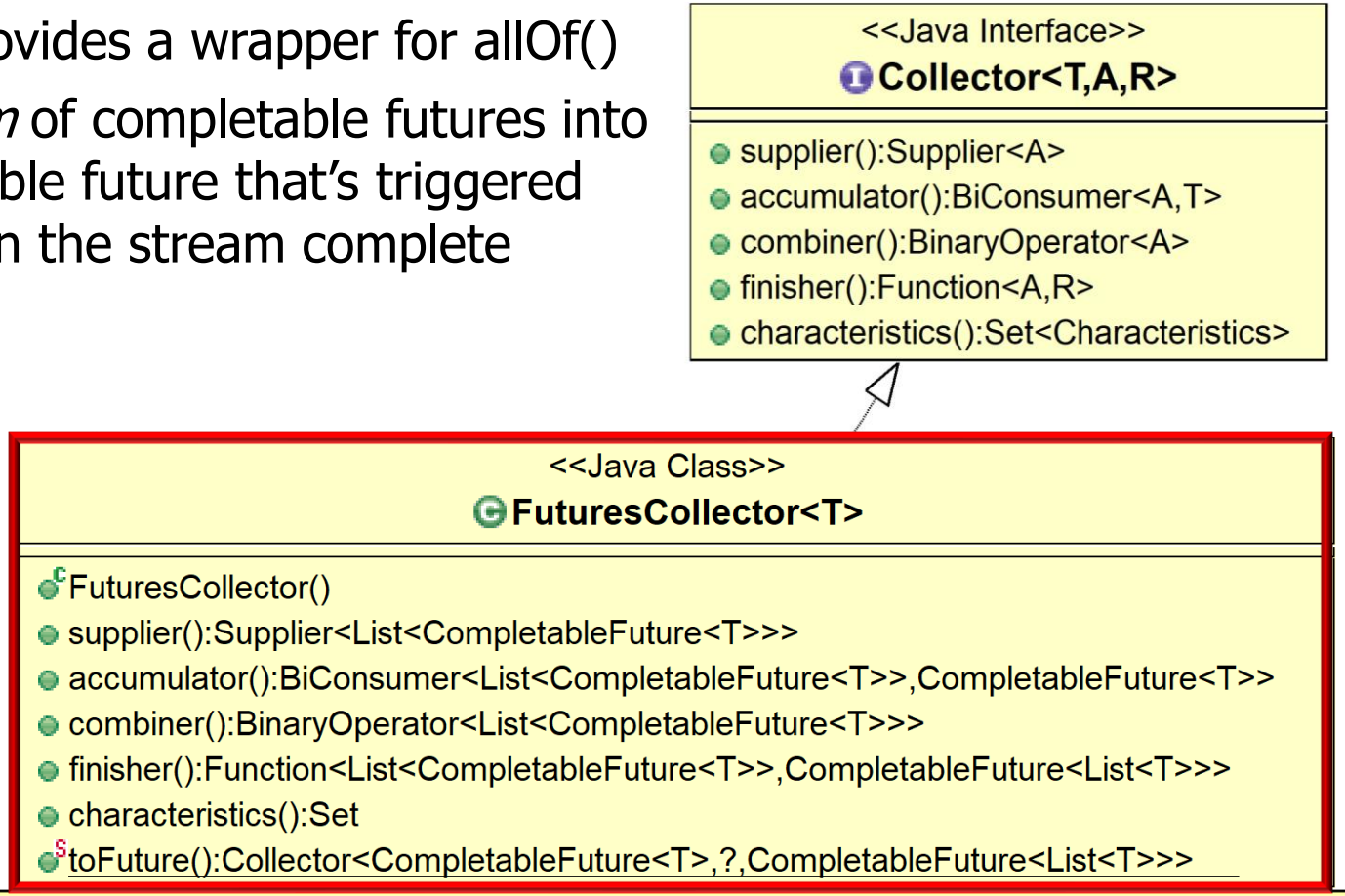
- FuturesCollector provides a wrapper for allOf()




See Java8/ex8/utils/FuturesCollector.java

# Implementing the FuturesCollector Class

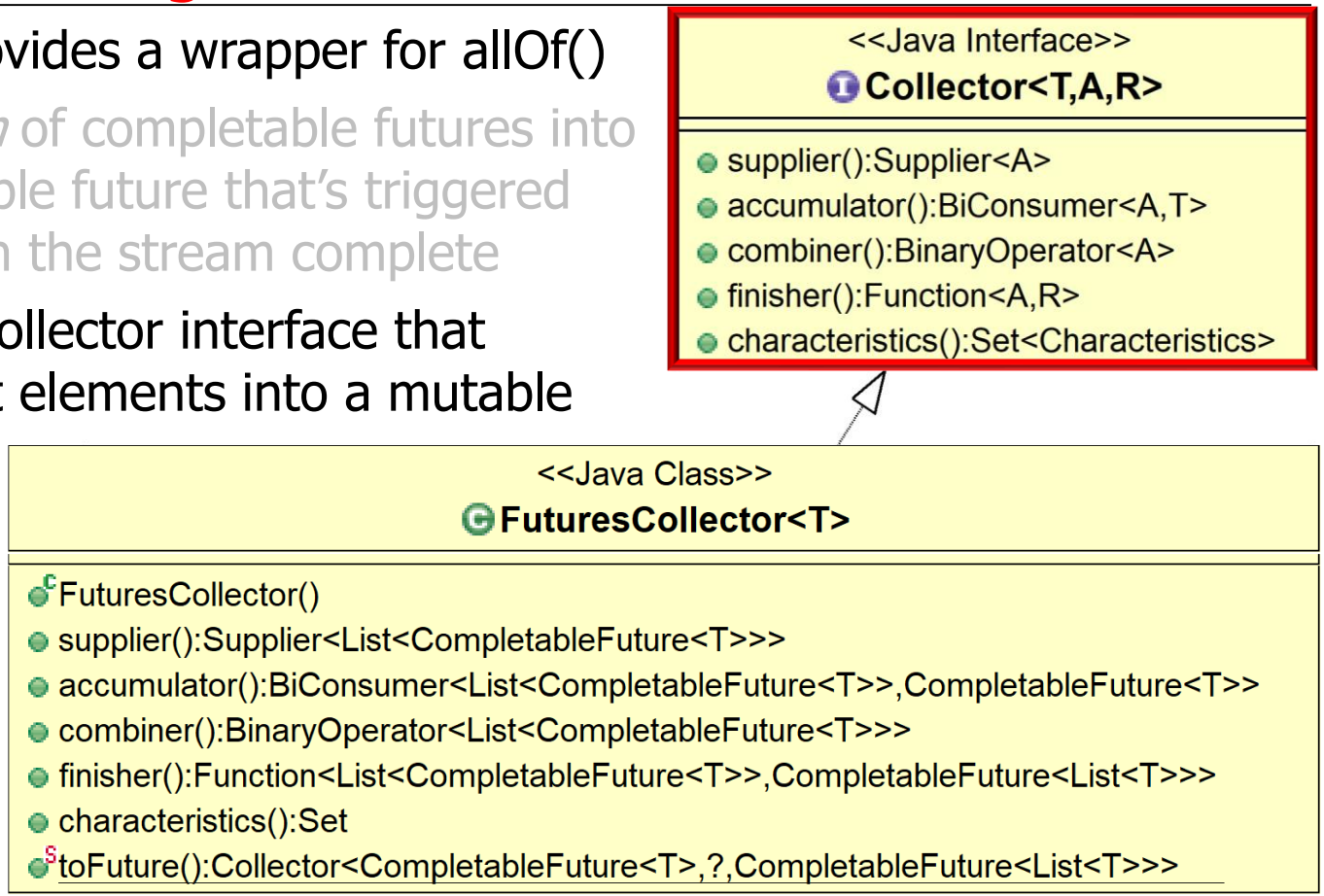
- FuturesCollector provides a wrapper for allOf()
  - Converts a *stream* of completable futures into a *single* completable future that's triggered when *all* futures in the stream complete




FuturesCollector is a non-concurrent collector (supports parallel & sequential streams)

# Implementing the FuturesCollector Class

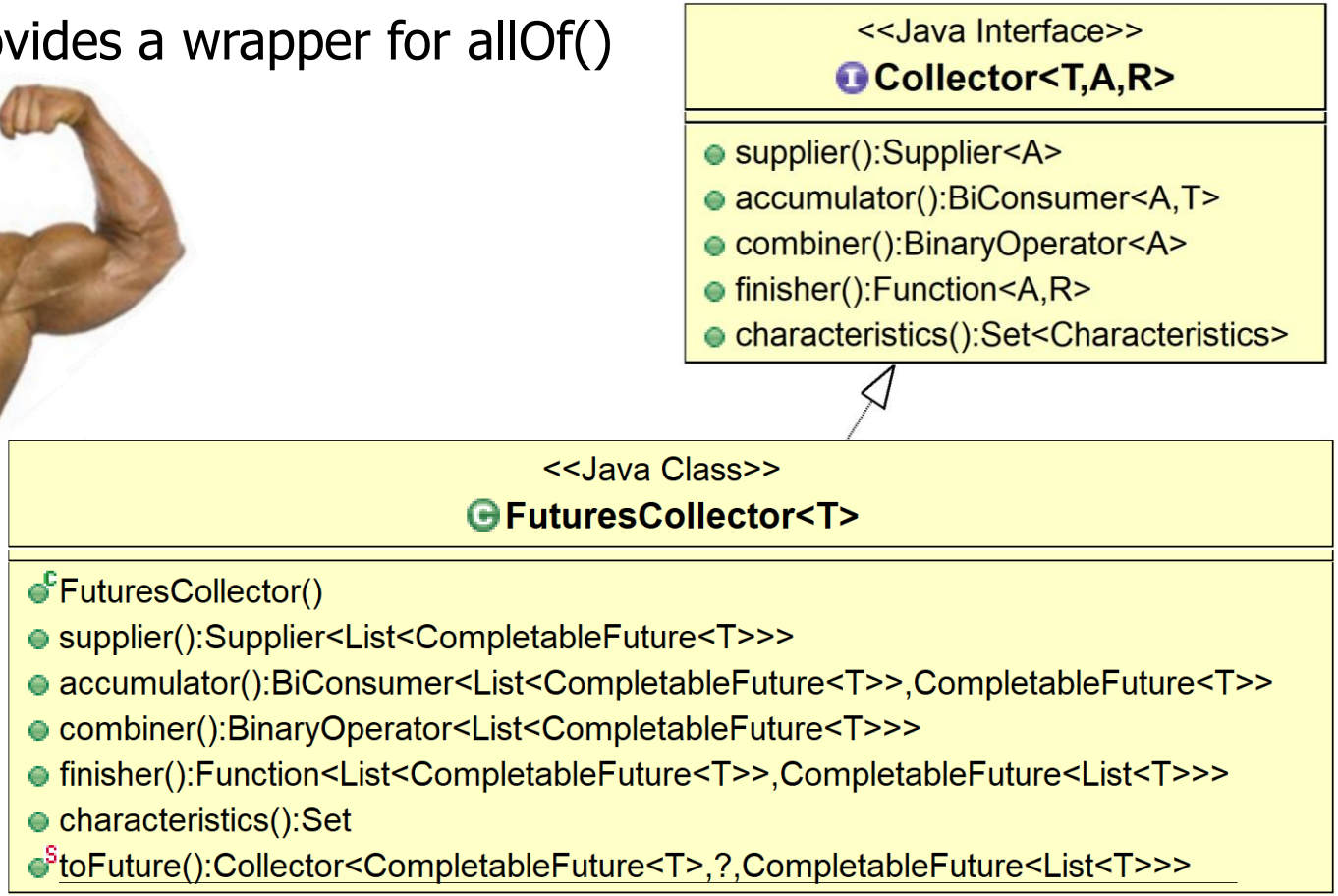
- FuturesCollector provides a wrapper for allOf()
  - Converts a *stream* of completable futures into a *single* completable future that's triggered when *all* futures in the stream complete
  - Implements the Collector interface that accumulates input elements into a mutable result container




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

# Implementing the FuturesCollector Class

- FuturesCollector provides a wrapper for allOf()




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

# Implementing the FuturesCollector Class

- 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

# Implementing the FuturesCollector Class

- FuturesCollector provides a wrapper for allOf()

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

*The type of input elements in the stream*

# Implementing the FuturesCollector Class

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

*The mutable result container type*

# Implementing the FuturesCollector Class

- FuturesCollector provides a wrapper for allOf()

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

*The result type of final output of the collector*

# Implementing the FuturesCollector Class

- 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; }
  ...
```

*This factory method returns a supplier used by the Java streams collector framework to create a new mutable array list container*

# Implementing the FuturesCollector Class

- 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;
  }
```

*This mutable result container stores a list of completable futures of type T*

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

# Implementing the FuturesCollector Class

- 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;
  }
```

*This factory method returns a bi-consumer used by the Java streams collector framework to add a new completable future into the mutable array list container*

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

This method is only ever called in a single thread (so no locks are needed)

# Implementing the FuturesCollector Class

- 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;
    };
  }
  ...
```

*This factory method returns a binary operator that merges two partial array list results into a single array list (only relevant for parallel streams)*

This method is only ever called in a single thread (so no locks are needed)

# Implementing the FuturesCollector Class

- 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]))
```

*This factory method returns a function used by the Java streams collector framework to transform the array list multiple result container to the completable future result type*

```
       .thenApply(v -> futures.stream()
                              .map(CompletableFuture::join)
                              .collect(toList()));
   }
   ...
```

# Implementing the FuturesCollector Class

- 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]))
```

*Reference to the mutable result contain, which is an ArrayList.*

```
      .thenApply(v -> futures.stream()
                                .map(CompletableFuture::join)
                                .collect(toList()));
  }
  ...
```

# Implementing the FuturesCollector Class

- FuturesCollector provides a wrapper for allOf()

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public class FuturesCollector<T>
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  public Function<List<CompletableFuture<T>>,
                          CompletableFuture<List<T>>> finisher() {
    return futures -> CompletableFuture
      .allOf(futures.toArray(new CompletableFuture[0]))
```

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

```
      .thenApply(v -> futures.stream()
                                .map(CompletableFuture::join)
                                .collect(toList()));
  }
  ...
```

# Implementing the FuturesCollector Class

- 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]))
```

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

```
      .thenApply(v -> futures.stream()
                                .map(CompletableFuture::join)
                                .collect(toList()));
  }
  ...
```

# Implementing the FuturesCollector Class

- 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()));
  }
  ...
```

*Convert the array list of futures into a stream of futures*

# Implementing the FuturesCollector Class

- 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()));
  }
  ...
```

*This call to join() will never block!*

# Implementing the FuturesCollector Class

- 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()));
   }
   ...
```

*Return a future to a list of elements of T*

# Implementing the FuturesCollector Class

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

```
static void testFractionMultiplications1() {
   ...
   Stream.generate(() -> makeBigFraction(new Random(), false))

         .limit(sMAX_FRACTIONS)

         .map(reduceAndMultiplyFraction)

         .collect(FuturesCollector.toFuture())

         .thenAccept(this::sortAndPrintList);
}
```

*thenAccept() is called only when the future returned from collect() completes*

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

# Implementing the FuturesCollector Class

- 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 FuturesCollector characteristics*

FuturesCollector is thus a *non-concurrent* collector

# Implementing the FuturesCollector Class

- 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<>();
  }
}
```

*This static factory method creates a new FuturesCollector*

# End of Advanced Java CompletableFuture Features: Implementing FuturesCollector