Advanced Java CompletableFuture Features: Handling Runtime Exceptions (Part 2)

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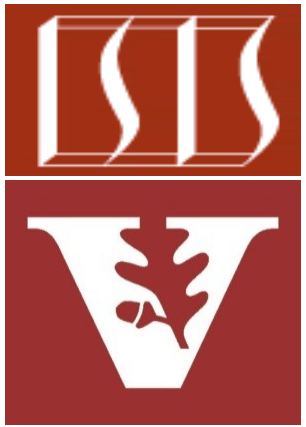

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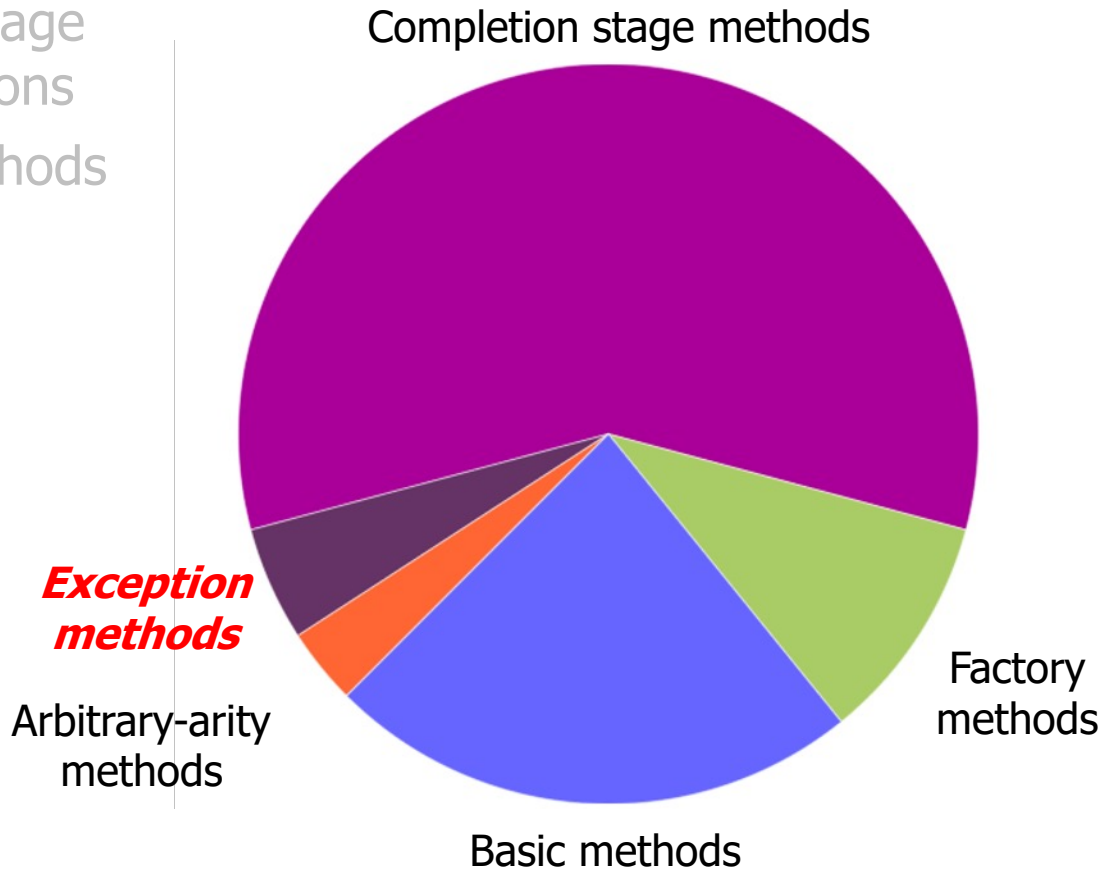
Learning Objectives in this Part of the Lesson

- Understand how completion stage methods chain dependent actions
- Know how to group these methods
- Single stage methods
- Two stage methods (and)
- Two stage methods (or)
- Apply these methods
- Handle runtime exceptions
  - Sync vs. async exceptions
  - Overview of methods
  - Applying these methods



Examples of Handling Exceptions in Completion Stages

Examples of Handling Exceptions in Completion Stages

- Show 3 ways to handle exceptions w/Java's completable futures framework

```
CompletableFuture
   .supplyAsync(() ->
                BigFraction.valueOf(100, denominator))

   ...
```

An exception will occur if denominator param is 0!

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

Examples of Handling Exceptions in Completion Stages

- Show 3 ways to handle exceptions w/Java's completable futures framework

```
CompletableFuture
   .supplyAsync(() ->
                    BigFraction.valueOf(100, denominator))
   ...
```

An unhandled exception will terminate a program!

See rollbar.com/guides/java-throwing-exceptions

Examples of Handling Exceptions in Completion Stages

- Using the handle() method to handle exceptional or normal completions

```
CompletableFuture
   .supplyAsync(() ->
                BigFraction.valueOf(100, denominator))

   .handle((fraction, ex) -> {
           if (fraction == null)
             return BigFraction.ZERO;
           else
             return fraction.multiply(sBigReducedFraction);
       })

   .thenAccept(fraction ->
               System.out.println(fraction.toMixedString()));
```

Handle outcome of the previous stage (always called, regardless of whether an exception is thrown)

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

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- Using the handle() method to handle exceptional or normal completions

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               System.out.println(fraction.toMixedString()));
```

These values are mutually exclusive

Examples of Handling Exceptions in Completion Stages

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           else
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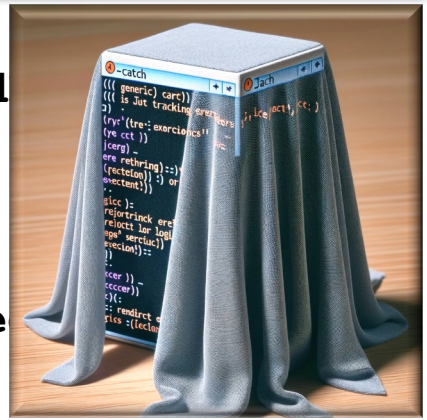
       })

   .thenAccept(fraction ->
                System.out.println(fraction.toMixe
```

The exception path converts ("swallows") an exception & returns BigFraction.ZERO



See en.wikipedia.org/wiki/Error_hiding

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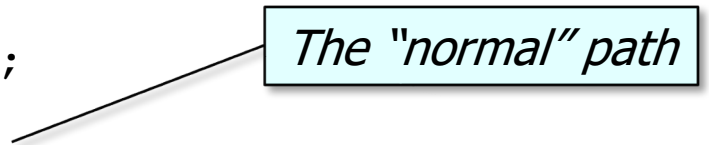

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```

handle() must return a value (& can thus change the return value)

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             return fraction.multiply(sBigReducedFraction);
       })

   .thenAccept(fraction ->
               System.out.println(fraction.toMixedString()));
```

Display result as a mixed fraction

Examples of Handling Exceptions in Completion Stages

- Using the exceptionally() method to handle exceptional or normal completions

```
CompletableFuture
   .supplyAsync(() ->
                  BigFraction.valueOf(100, denominator))

   .thenApply(fraction ->
              fraction.multiply(sBigReducedFraction))

   .exceptionally(ex -> BigFraction.ZERO)


   .thenAccept(fraction ->
                System.out.println(fraction.toMixedString()));
```

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

Examples of Handling Exceptions in Completion Stages

- Using the exceptionally() method to handle exceptional or normal completions

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CompletableFuture
   .supplyAsync(() ->
                  BigFraction.valueOf(100, denominator))

   .thenApply(fraction ->
                fraction.multiply(sBigReducedFraction))

   .exceptionally(ex -> BigFraction.ZERO)


   .thenAccept(fraction ->
                System.out.println(fraction.toMixedString()));
```

An exception occurs if denominator is 0!

Examples of Handling Exceptions in Completion Stages

- Using the exceptionally() method to handle exceptional or normal completions

```
CompletableFuture
   .supplyAsync(() ->
                  BigFraction.valueOf(100, denominator))

   .thenApply(fraction ->
                fraction.multiply(sBigReducedFraction))

   .exceptionally(ex -> BigFraction.ZERO)
```

Handle case where denominator != 0 (skipped if exception is thrown)

```
   .thenAccept(fraction ->
                 System.out.println(fraction.toMixedString()));
```

Examples of Handling Exceptions in Completion Stages

- Using the exceptionally() method to handle exceptional or normal completions

```
CompletableFuture
   .supplyAsync(() ->
                BigFraction.valueOf(100, denominator))

   .thenApply(fraction ->
              fraction.multiply(sBigReducedFraction))

   .exceptionally(ex -> BigFraction.ZERO)

   .thenAccept(fraction ->
               System.out.println(fraction.toMixedString()));
```

Handle case where denominator == 0 & exception is thrown (otherwise skipped)

exceptionally() is akin to catch() in a Java try/catch block, i.e., control xfers to it

Examples of Handling Exceptions in Completion Stages

- Using the exceptionally() method to handle exceptional or normal completions

```
CompletableFuture
   .supplyAsync(() ->
                BigFraction.valueOf(100, denominator))

   .thenApply(fraction ->
              fraction.multiply(sBigReducedFraction))

   .exceptionally(ex -> BigFraction.ZERO)

   .thenAccept(fraction ->
               System.out.println(fraction.toMixedString()));
```

Convert ("swallow") an exception to a 0 result

See en.wikipedia.org/wiki/Error_hiding

Examples of Handling Exceptions in Completion Stages

- Using the exceptionally() method to handle exceptional or normal completions

```
CompletableFuture
   .supplyAsync(() ->
                  BigFraction.valueOf(100, denominator))

   .thenApply(fraction ->
                fraction.multiply(sBigReducedFraction))

   .exceptionallyAsync(ex -> BigFraction.ZERO)

   .thenAccept(fraction ->
                 System.out.println(fraction.toMixedString()));
```

Can be used if exception handling takes a long time

See docs.oracle.com/en/java/javase/12/docs/api/java.base/java/util/concurrent/CompletionStage.html#exceptionallyAsync

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- Using the exceptionally() method to handle exceptional or normal completions

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CompletableFuture
   .supplyAsync(() ->
                  BigFraction.valueOf(100, denominator))

   .thenApply(fraction ->
                fraction.multiply(sBigReducedFraction))

   .exceptionally(ex -> BigFraction.ZERO)

   .thenAccept(fraction ->
                System.out.println(fraction.toMixedString()));
```

Display result as a mixed fraction

Examples of Handling Exceptions in Completion Stages

- Using the whenComplete() method to perform a exceptional or normal action

```
CompletableFuture
   .supplyAsync(() ->
                BigFraction.valueOf(100, denominator))

   .thenApply(fraction ->
              fraction.multiply(sBigReducedFraction))

   .whenComplete((fraction, ex) -> {
      if (fraction != null)
        System.out.println(fraction.toMixedString());
      else
        System.out.println(ex.getMessage());
    });
```

Called under both normal & exception conditions

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

Examples of Handling Exceptions in Completion Stages

- Using the whenComplete() method to perform a exceptional or normal action

```
CompletableFuture
   .supplyAsync(() ->
                BigFraction.valueOf(100, denominator))

   .thenApply(fraction ->
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   .whenComplete((fraction, ex) -> {
      if (fraction != null)
        System.out.println(fraction.toMixedString());
      else
        System.out.println(ex.getMessage());
    });
```

These values are mutually exclusive

Examples of Handling Exceptions in Completion Stages

- Using the whenComplete() method to perform a exceptional or normal action

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CompletableFuture
   .supplyAsync(() ->
                BigFraction.valueOf(100, denominator))

   .thenApply(fraction ->
              fraction.multiply(sBigReducedFraction))


   .whenComplete((fraction, ex) -> {
      if (fraction != null)
        System.out.println(fraction.toMixedString());
      else
        System.out.println(ex.getMessage());
    });
```

Handle the normal case

Examples of Handling Exceptions in Completion Stages

- Using the whenComplete() method to perform a exceptional or normal action

```
CompletableFuture
   .supplyAsync(() ->
                BigFraction.valueOf(100, denominator))

   .thenApply(fraction ->
              fraction.multiply(sBigReducedFraction))


   .whenComplete((fraction, ex) -> {
      if (fraction != null)
        System.out.println(fraction.toMixedString());
      else // ex != null
        System.out.println(ex.getMessage());
    });
```

Handle the exceptional case

Examples of Handling Exceptions in Completion Stages

- Using the whenComplete() method to perform a exceptional or normal action

```
CompletableFuture
   .supplyAsync(() ->
                BigFraction.valueOf(100, denominator))

   .thenApply(fraction ->
              fraction.multiply(sBigReducedFraction))

   .whenComplete((fraction,
      if (fraction != null)
        System.out.println(fraction.toMixedString());
      else // ex != null
        System.out.println(ex.getMessage());
    });
```

whenComplete() is like Java Streams.peek(), i.e., it has a side-effect, doesn't change the return value, & doesn't swallow the exception

See docs.oracle.com/javase/8/docs/api/java/util/stream/Stream.html#peek

End of Advanced Java CompletableFuture Features: Handling Runtime Exceptions (Part 2)