Java CompletableFutures ImageStreamGang Example: Applying Completion Stage Methods (Part 2)

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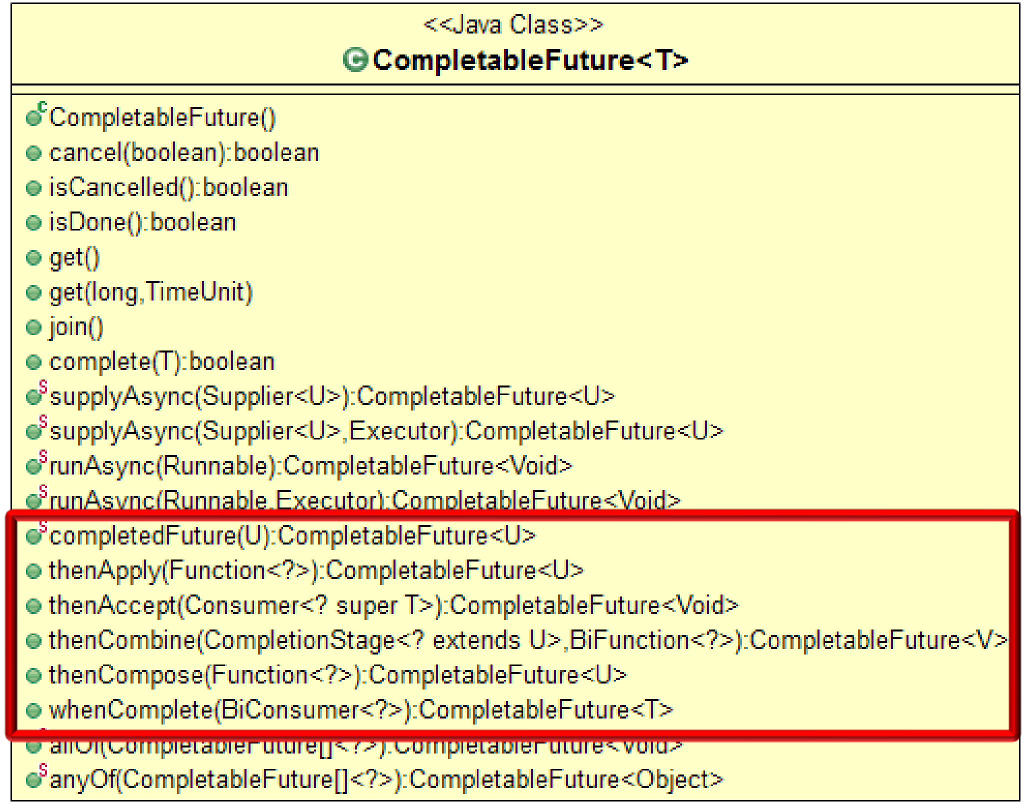
Learning Objectives in this Part of the Lesson

- Understand the design of the Java completable future version of ImageStreamGang
- Know how to apply completable futures to ImageStreamGang, e.g.
  - Factory methods
  - Completion stage methods
    - downloadImageAsync()
    - applyFiltersAsync()



```
<<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>
```

Applying Completion Stage Methods in ApplyFiltersAsync

Applying Completion Stage Methods in ApplyFiltersAsync

- Asynchronously filter & store downloaded images on the local file system

```
void processStream() {
  List<URL> urls = getInput();

  CompletableFuture<Stream<Image>>
    resultsFuture = urls
    .stream()
    .map(this::checkUrlCachedAsync)
    .map(this::downloadImageAsync)
    .flatMap(this::applyFiltersAsync)
    .collect(toFuture())
    .thenApply(stream ->
               log(stream.flatMap
                   (Optional::stream),
                    urls.size()))
    .join();
```

flatMap() calls behavior applyFiltersAsync()

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```

Asynchronous filter images & store them into files

Later operations ignore "empty" optional images

Applying Completion Stage Methods in ApplyFiltersAsync

- Asynchronously filter & store downloaded images on the local file system

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```

"Flatten" all filtered/stored images into a single output stream

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

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    .thenApply(stream ->
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                   urls.size()))
    .join();
```

Returns a stream of futures to optional images, which have a value if the image is being filtered or are empty if it is already cached

Applying Completion Stage Methods in ApplyFiltersAsync

- applyFiltersAsync() uses the thenApplyAsync() method internally

```
Stream<CompletableFuture<Optional<Image>>> applyFiltersAsync
                (CompletableFuture<Optional<Image>> imageFuture) {
  return mFilters
    .stream()

    .map(filter -> imageFuture
         .thenApplyAsync(imageOpt ->
                         imageOpt
                         .map(image ->
                              makeFilterDecoratorWithImage
                                (filter, image).run()),
                         getExecutor()));
}
```

Asynchronously filter images & then store them into files

See imagestreamgang/streams/ImageStreamCompletableFuture1.java

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}
```

Convert the list of filters into a stream

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}
```

Asynchronously apply a filter action after image completes downloading

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

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```

This completion stage method registers an action that's not executed immediately, but runs only after imageFuture completes

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                         getExecutor()));}
```

If an image is present then perform the action & return optional containing result; otherwise return an empty optional

See docs.oracle.com/javase/8/docs/api/java/util/Optional.html#map

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```

If image is non-empty then asynchronously filter the image & store it in an output file

See en.wikipedia.org/wiki/Decorator_pattern

Applying Completion Stage Methods in ApplyFiltersAsync

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```

thenApplyAsync() runs action in a worker thread from the common fork-join pool

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                         getExecutor()));
}
```

It also returns a new completable future that will trigger when the image has been filtered/stored

Applying Completion Stage Methods in ApplyFiltersAsync

- applyFiltersAsync() uses the thenApplyAsync() method internally

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                         getExecutor()));
}
```

applyFiltersAsync() returns a stream of completable futures to optional images

Applying Completion Stage Methods in ApplyFiltersAsync

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                         .map(image ->
                              makeFilterDecoratorWithImage
                                (filter, image).run()),
                         getExecutor()));
}
```

There is no terminal operation here, so a stream is returned!

Applying Completion Stage Methods in ApplyFiltersAsync

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```
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    .flatMap(this::applyFiltersAsync)
    .collect(toFuture())
    .thenApply(stream ->
               log(stream.flatMap
                   (Optional::stream),
                    urls.size()))
    .join();
```

flatMap() merges the streams of futures returned by applyFilters Async() into just one stream

This stream is processed by collect(), as discussed in the next part of the lesson

Applying Completion Stage Methods in ApplyFiltersAsync

- Asynchronously filter & store downloaded images on the local file system

```
void processStream() {
  List<URL> urls = getInput();

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    .thenApply(stream ->
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    .join();
```

This stream is processed by collect(), as discussed in the next parts of the lesson

End of Applying Completion Stage Methods in Image StreamGang (Part 2)