Learn How to Implement Behaviors in the Java Parallel ImageStreamGang Case Study

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Learning Objectives in this Part of the Lesson

- Understand the structure/functionality of the ImageStreamGang app
- Visualize how Java parallel streams are applied to the ImageStreamGang app
- Learn how to implement parallel streams behaviors of ImageStreamGang

```
void processStream() {
  List<Image> filteredImages =
  getInput()
     .parallelStream()
     .filter(not(this::urlCached))
     .map(this::blockingDownload)
     .map(this::applyFilters)
     .reduce(Stream::concat)
     .orElse(Stream.empty())
     .collect(toList());

  System.out.println(TAG
        + "Image(s) filtered = "
        + filteredImages.size());
}
```

See github.com/douglascraigschmidt/LiveLessons/blob/master/ImageStreamGang

Implementing a Parallel Stream in ImageStreamGang

Implementing a Parallel Stream in ImageStreamGang

- We focus on processStream() in ImageStreamParallel.java

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void processStream() {
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```

See imagestreamgang/streams/ImageStreamParallel.java

Implementing a Parallel Stream in ImageStreamGang

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Get a list of URLs

```
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```

getInput() is defined by the underlying StreamGang framework

Implementing a Parallel Stream in ImageStreamGang

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Convert a collection into a parallel stream

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Implementing a Parallel Stream in ImageStreamGang

- We focus on processStream() in ImageStreamParallel.java

Return an output stream consisting of the URLs in the input stream that are not already cached

```
void processStream() {
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```

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

Implementing a Parallel Stream in ImageStreamGang

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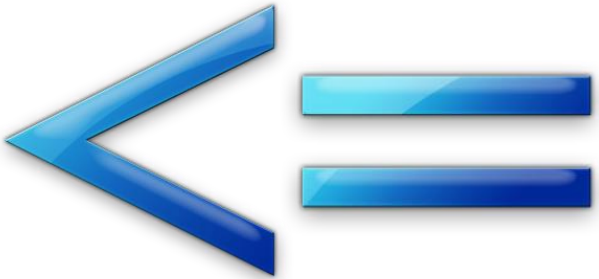
Return an output stream consisting of the URLs in the input stream that are not already cached



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```

# of output stream elements will be <= # of input stream elements

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```

```
boolean urlCached(URL url) {
  return mFilters
    .stream()
    .anyMatch(filter ->
       urlCached(url,
                 filter
                 .getName()));
}
```

Determine whether this url has been downloaded to an image & had filters applied to it yet

See imagestreamgang/streams/ImageStreamGang.java

Implementing a Parallel Stream in ImageStreamGang

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```

```
boolean urlCached(URL url,
          String filterName) {
  File file =
    new File(getPath(),
             filterName);

  File imageFile =
    new File(file,
          getNameForUrl(url));

  return imageFile.exists();
}
```

Check if a file with this name already exists

See imagestreamgang/streams/ImageStreamGang.java

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There are clearly better ways of implementing an image cache!

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Return an output stream consisting of the images that were downloaded from the URLs in the input stream

# of output stream elements must match the # of input stream elements

Implementing a Parallel Stream in ImageStreamGang

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```

```
Image blockingDownload
                (URL url) {
  return BlockingTask
   .callInManagedBlock
     (() ->
      downloadImage(url));
}
```

Downloads content from a url & converts it into an image

See imagestreamgang/streams/ImageStreamParallel.java

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Uses a "managed blocker" to ensure sufficient threads are in the common fork-join pool

See lesson on "*The Java Fork-Join Pool: Applying the ManagedBlocker Interface*"

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I/O-bound tasks on an N-core CPU typically run best with N(1+WT/ST) threads (WT = wait time & ST = service time)*

See stackoverflow.com/a/19563172

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```

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

Implementing a Parallel Stream in ImageStreamGang

- We focus on processStream() in ImageStreamParallel.java

Return an output stream-of-streams containing results of applying a list of filters to each image in the input stream & storing results in the file system

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void processStream() {
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# of output stream elements must match the # of input stream elements

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}
```

```
Stream<Image> applyFilters
                    (Image image) {
  return mFilters
     .parallelStream()
     .map(filter ->
          makeFilterWithImage
           (filter,
            image).run())
}
```

Apply all filters to an image in parallel & store on the device

See imagestreamgang/streams/ImageStreamParallel.java

Implementing a Parallel Stream in ImageStreamGang

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```

Perform flattening manually by replacing flatMap() with map() + reduce(Stream::concat)

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

Implementing a Parallel Stream in ImageStreamGang

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```

This idiom works-around a limitation with flatMap() for parallel streams

See stackoverflow.com/questions/45038120/parallel-flatmap-always-sequential/66386078

Implementing a Parallel Stream in ImageStreamGang

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}
```

reduce() returns an Optional, so we need to handle that case, e.g., if all images were cached

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

Implementing a Parallel Stream in ImageStreamGang

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collect() is a "reduction" operation that combines elements into one result

```
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```

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

Implementing a Parallel Stream in ImageStreamGang

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Trigger all intermediate operations

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```

Create a list containing all the filtered & stored images

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  System.out.println(TAG
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}
```

Logs the # of images that were downloaded, filtered, & stored

End of Learn How to Implement Behaviors in the Java ParallelImageStream Gang Case Study