Java Parallel ImageStreamGang Example: Introduction

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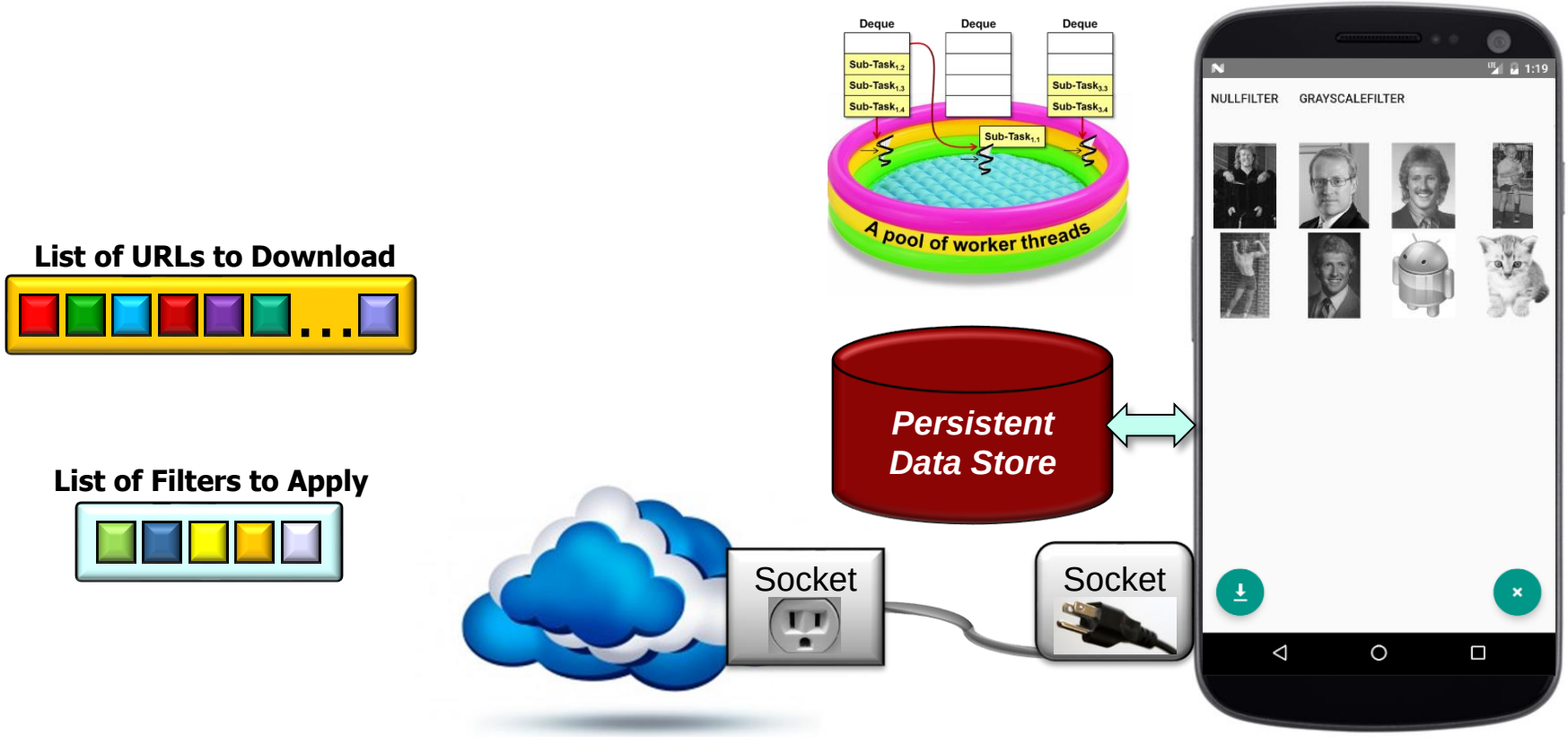
Learning Objectives in this Part of the Lesson

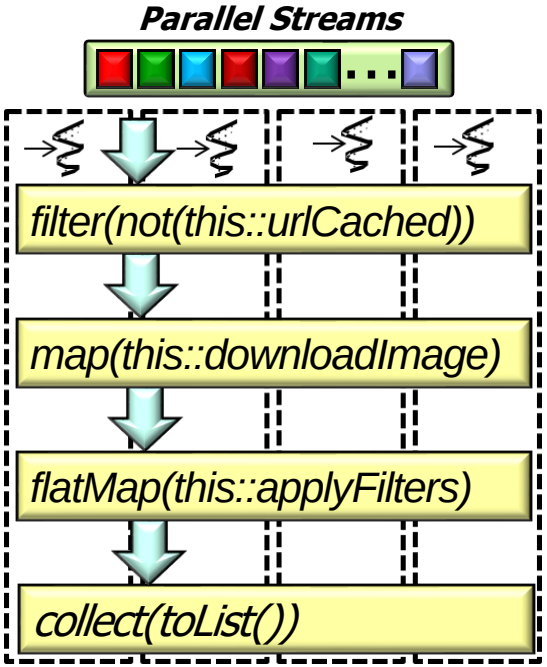
- Recognize the structure & functionality of the ImageStreamGang app

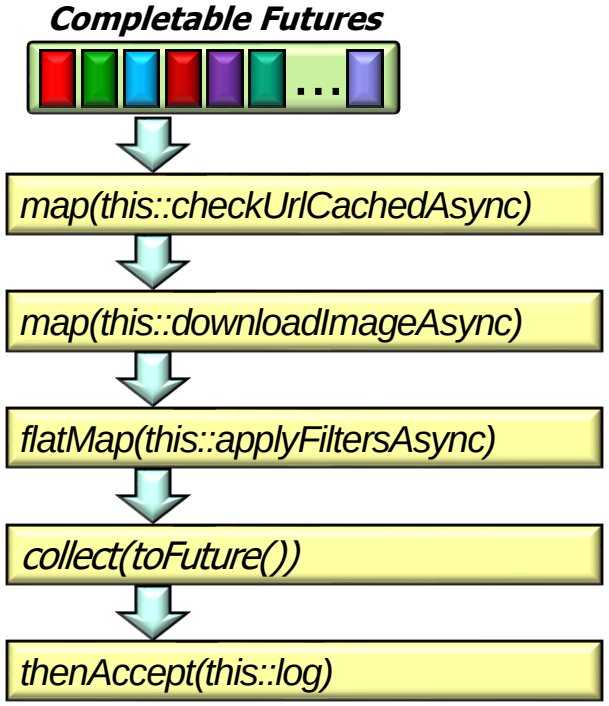


See github.com/douglascraigschmidt/LiveLessons/tree/master/ImageStreamGang

Learning Objectives in this Part of the Lesson

- Recognize the structure & functionality of the ImageStreamGang app
  - It applies several Java parallelism frameworks





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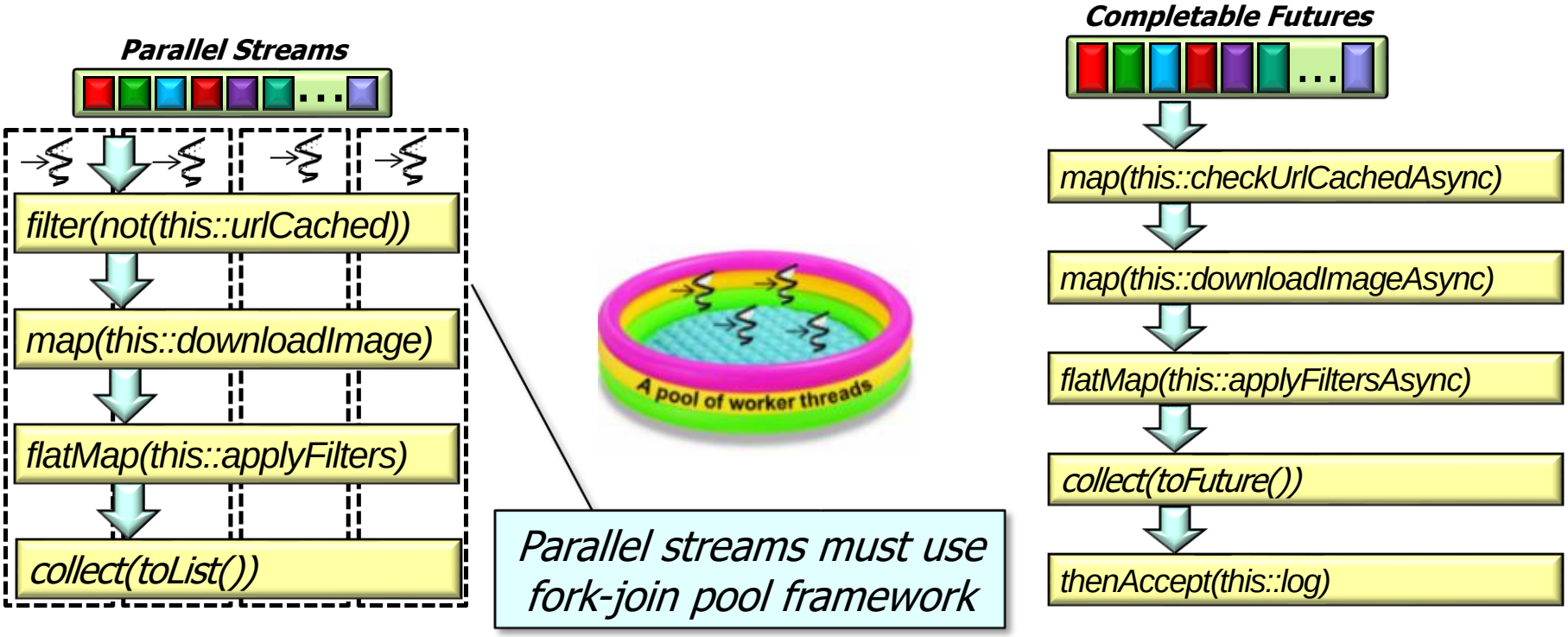

See docs.oracle.com/javase/tutorial/collections/streams/parallelism.html

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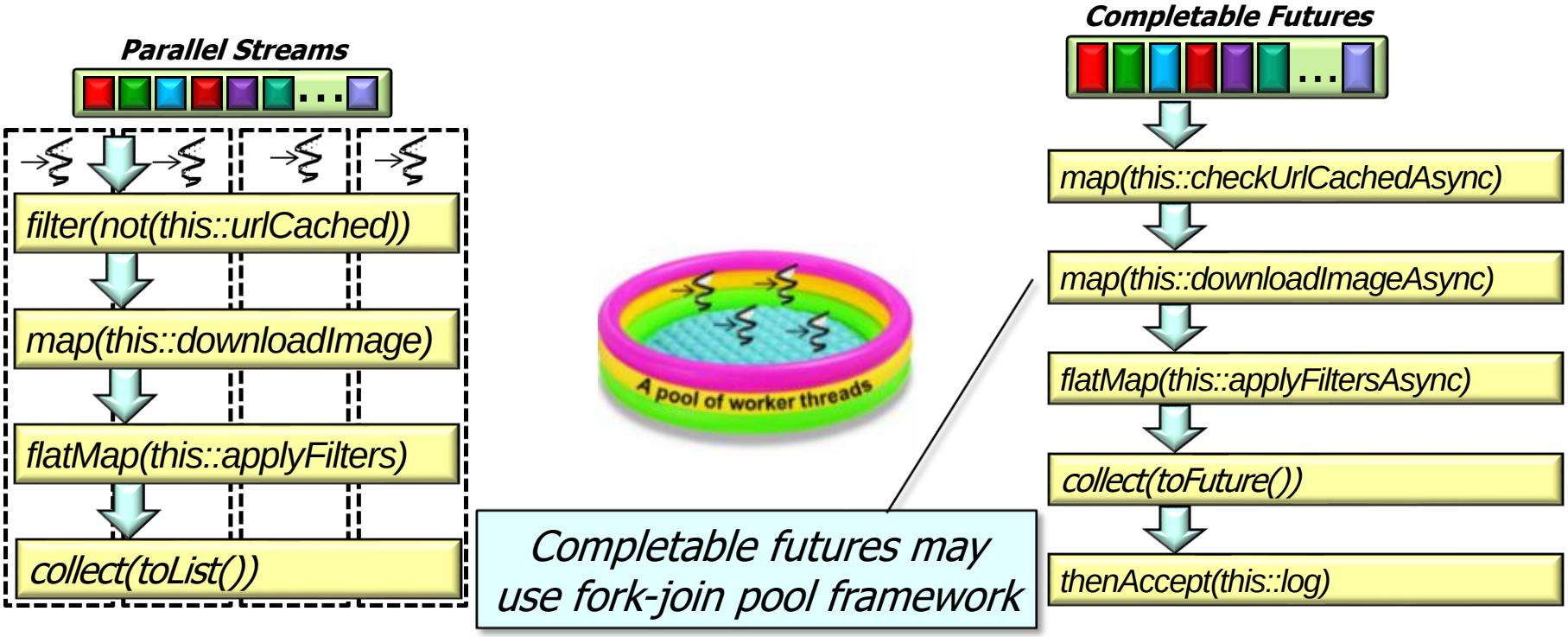
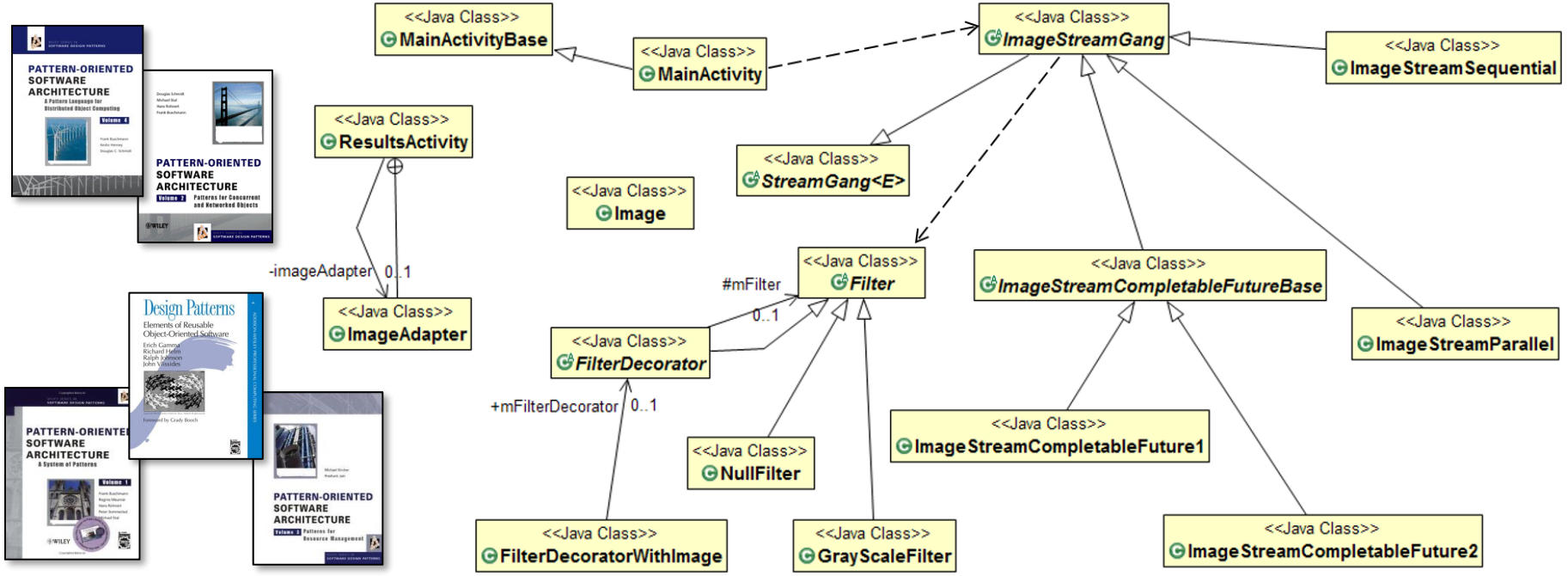


See www.nurkiewicz.com/2013/05/java-8-definitive-guide-to.html

Learning Objectives in this Part of the Lesson

- Recognize the structure & functionality of the ImageStreamGang app
  - It applies several Java parallelism frameworks
  - Focus is on integrating object-oriented & functional programming paradigms

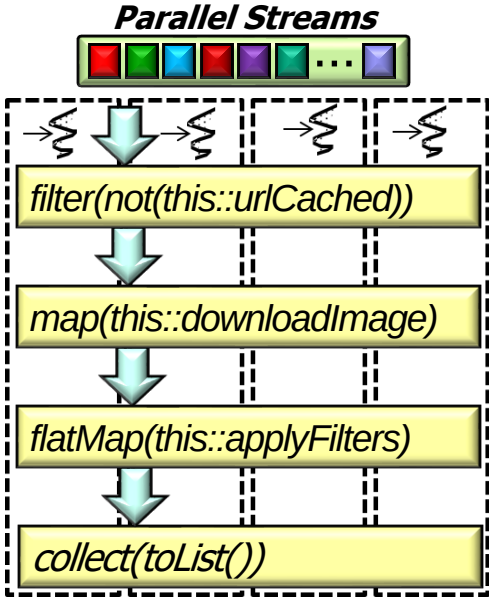


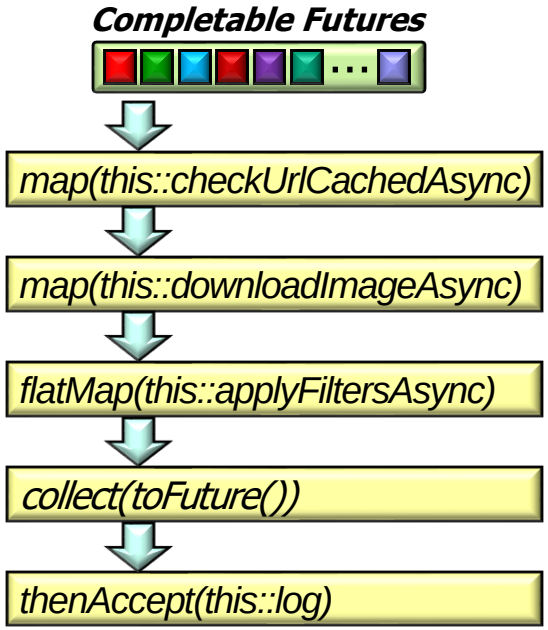
Patterns are used to emphasize key roles & responsibilities in the app's design

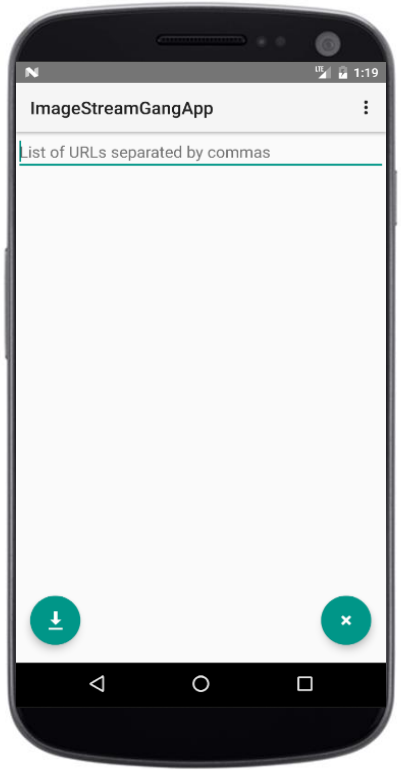
Overview of the Pattern-Oriented ImageStreamGang App

Overview of the Pattern-Oriented ImageStreamGang App

- This app combines streams & completable futures with the StreamGang framework to download, transform, store, & display images







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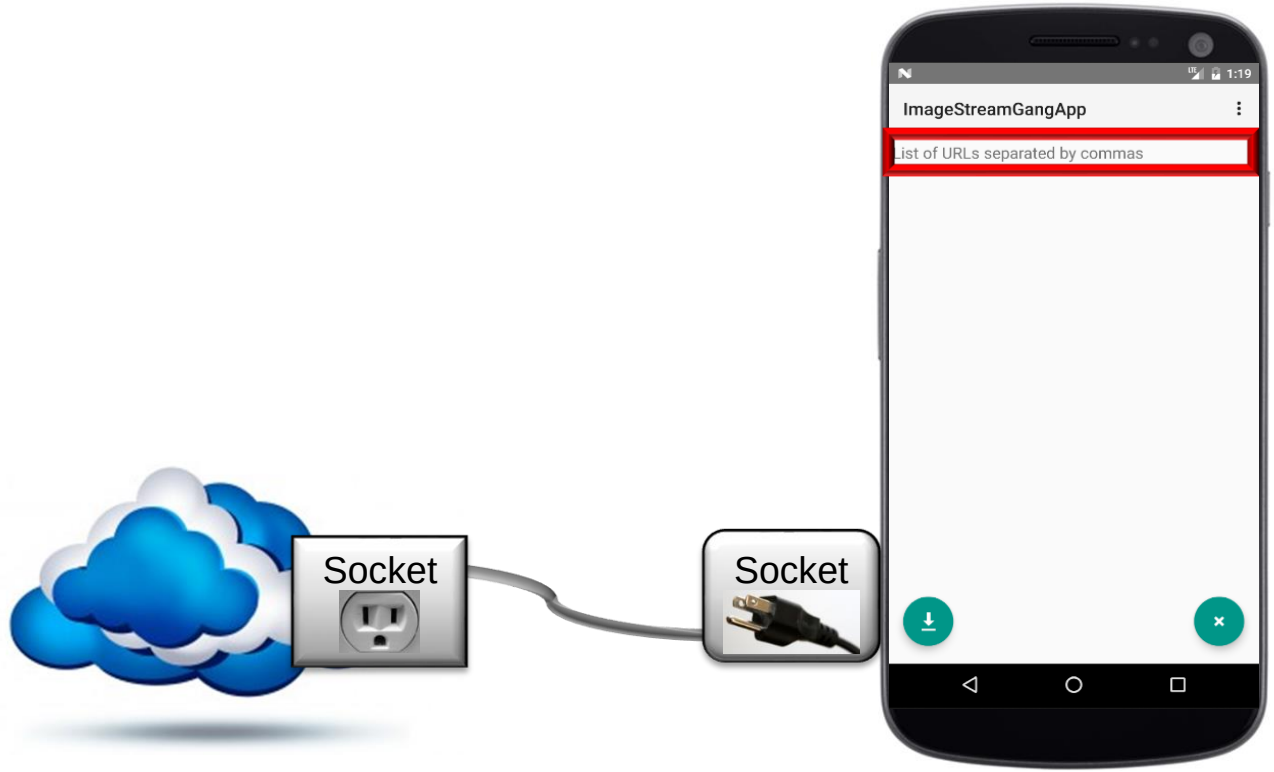

Prompt user for list of URLs to download

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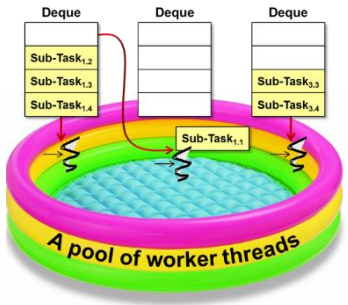

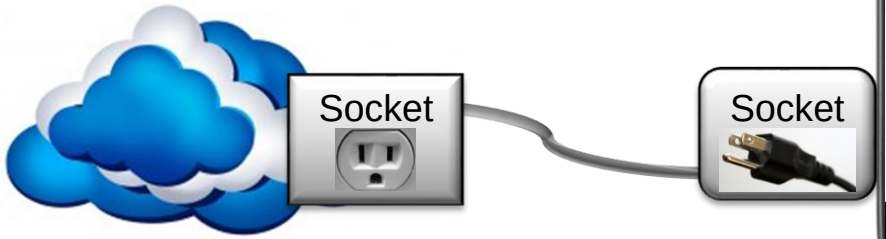

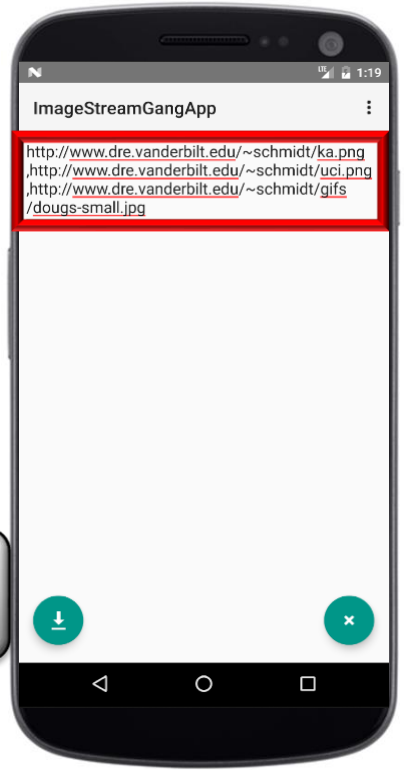

User supplies the list of URLs to download

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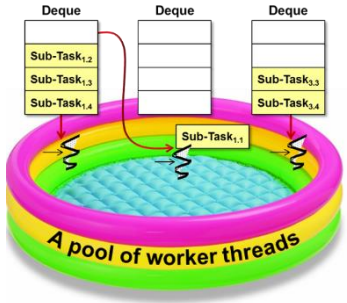

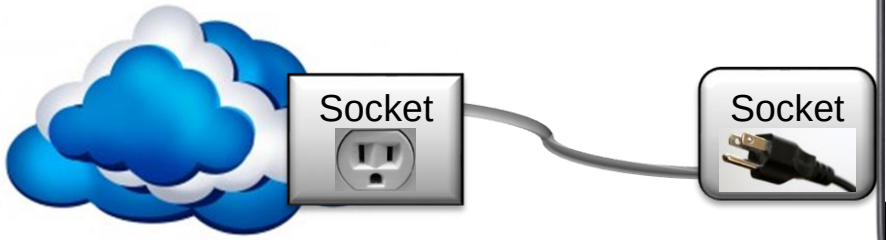

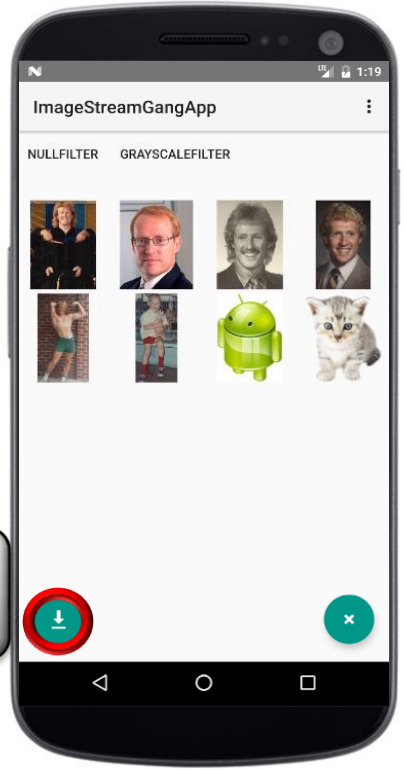

Download images via one or more threads

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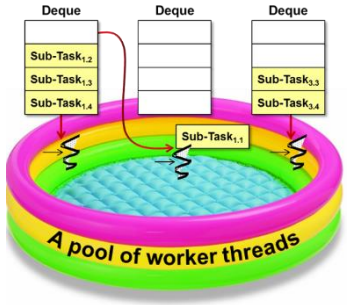

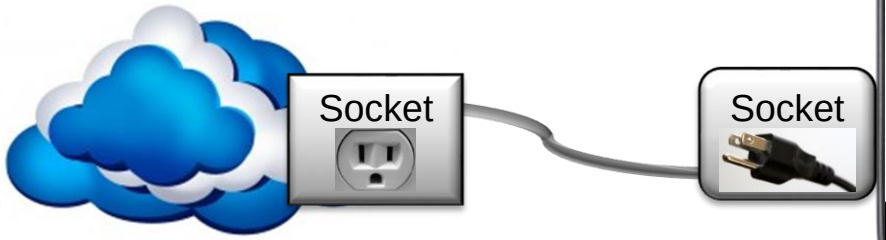

Apply filters to transform downloaded images

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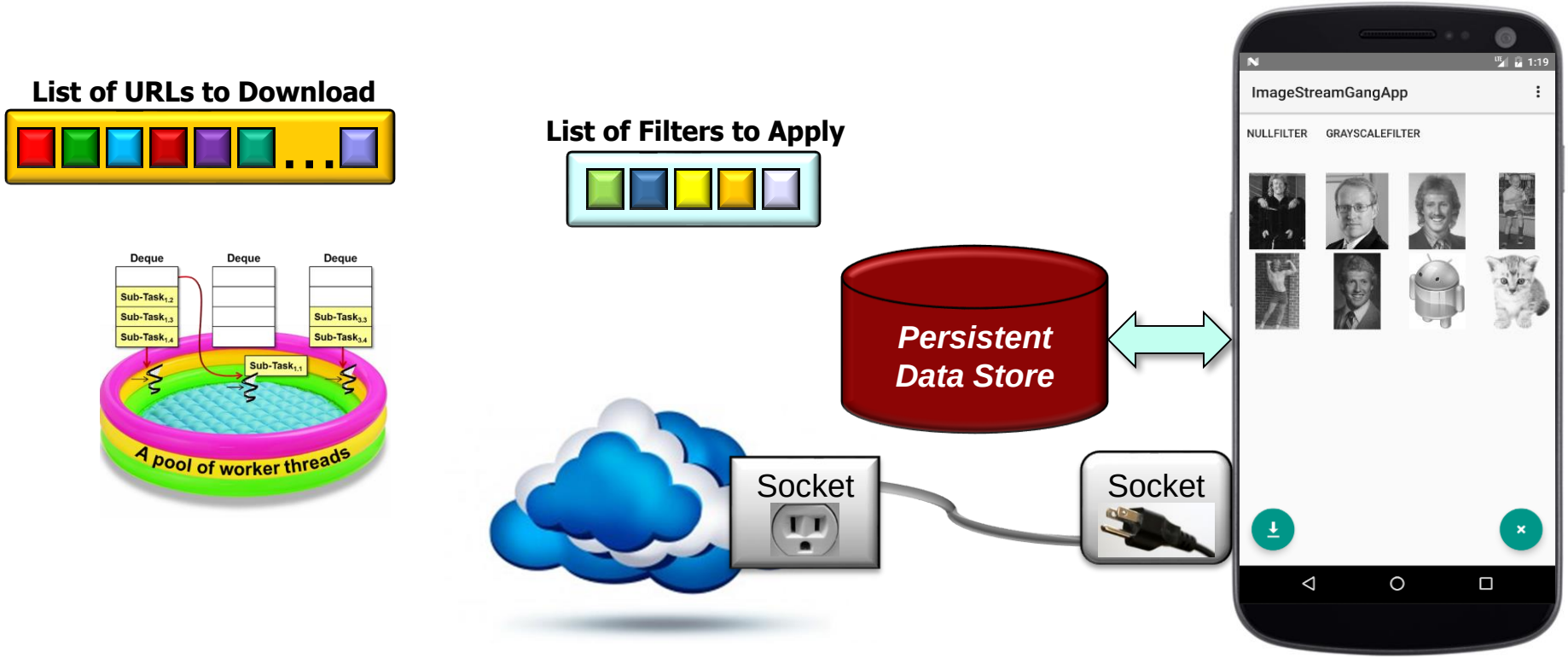
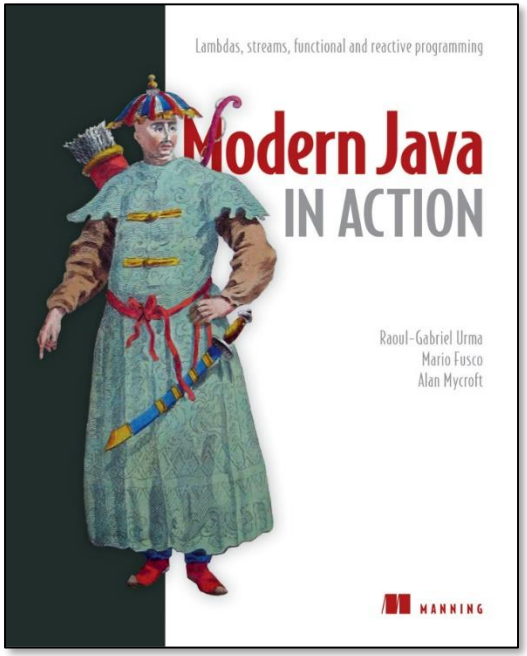


Output filtered images to persistent storage

Overview of the Pattern-Oriented ImageStreamGang App

- The ImageStreamGang app applies a range of modern Java features



See www.manning.com/books/modern-java-in-action

Overview of the Pattern-Oriented ImageStreamGang App

- The ImageStreamGang app applies a range of modern Java features, e.g.
  - Sequential & parallel streams

```
List<Image> filteredImages =
    getInput()
       .parallelStream()
       .filter(not(this::urlCached))
       .map(this::downloadImage)
       .flatMap(this::applyFilters)
       .collect(toList());
```

We'll cover parallel streams now

Overview of the Pattern-Oriented ImageStreamGang App

- The ImageStreamGang app applies a range of modern Java features, e.g.
  - Sequential & parallel streams
  - Completable futures

```
getInput()
  .stream()
  .map(this::checkUrlCachedAsync)
  .map(this::downloadImageAsync)
  .flatMap(this::applyFiltersAsync)
  .collect(toFuture())
  .thenAccept
    (stream ->
     log(stream.flatMap(Optional::stream),
         urls.size()))
  .join();
```

We cover completable futures later

Overview of the Pattern-Oriented ImageStreamGang App

- The ImageStreamGang app applies a range of modern Java features, e.g.
  - Sequential & parallel streams
  - Completable futures
  - Lambda expressions & method references

```
Runnable mCompletionHook =
   () -> MainActivity.this.runOnUiThread
      (this::goToResultActivity);
```

We covered these foundational Java features earlier

Overview of the Pattern-Oriented ImageStreamGang App

- The ImageStreamGang app applies a range of modern Java features, e.g.
  - Sequential & parallel streams
  - Completable futures
  - Lambda expressions & method references

```
Runnable mCompletionHook =
   () -> MainActivity.this.runOnUiThread
      (this::goToResultActivity);
```

versus

```
Runnable mCompletionHook = new Runnable() {
    public void run() {
    MainActivity.this.runOnUiThread
     (new Runnable() { public void run()
       { goToResultActivity(); } }); }};
```

Overview of Patterns Applied in the ImageStreamGang App

Overview of Patterns Applied in the ImageStreamGang App

- "Gang-of-Four" & POSA patterns are applied to enhance its framework-based architecture

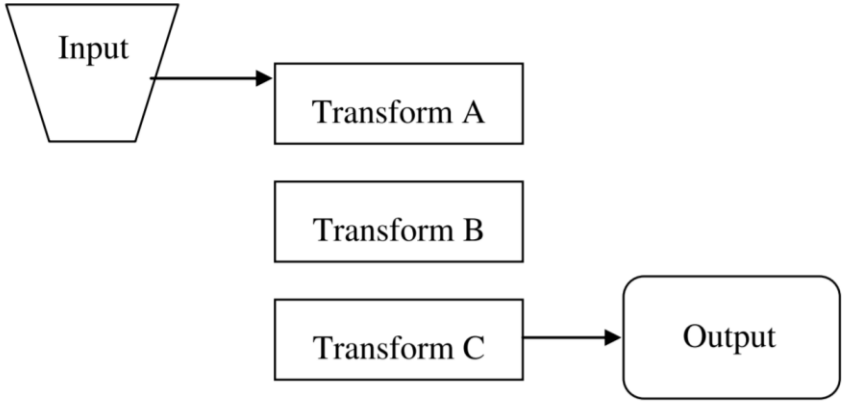
See en.wikipedia.org/wiki/Design_Patterns & www.dre.vanderbilt.edu/~schmidt/POSA

Overview of Patterns Applied in the ImageStreamGang App

- Some patterns are essential to its design

Overview of Patterns Applied in the ImageStreamGang App

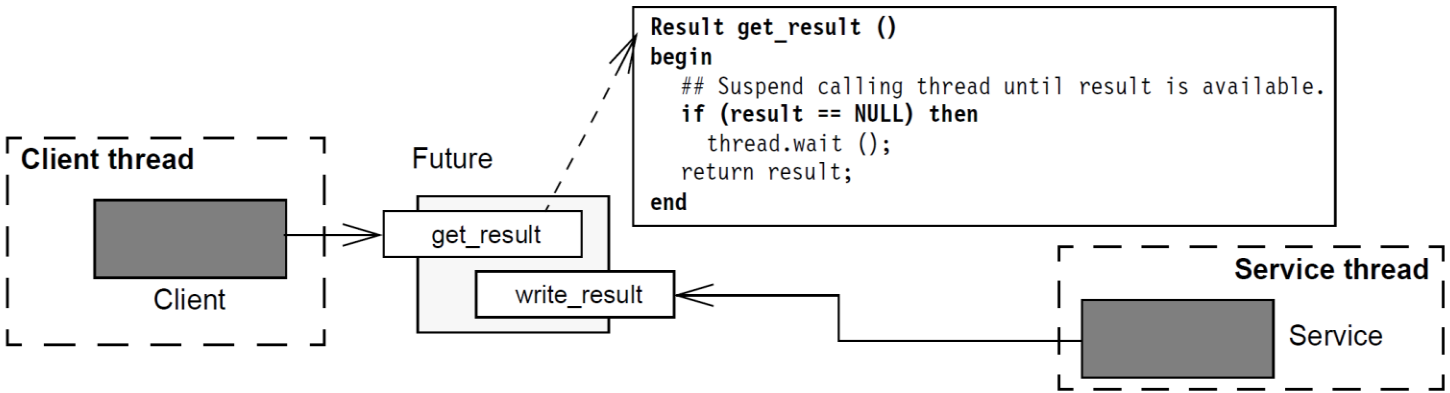
- Some patterns are essential to its design
  - *Pipes and Filters*
    - Divide application's tasks into several self-contained data processing steps & connect these steps via intermediate data buffers to a data processing pipeline



See www.hillside.net/plop/2011/papers/B-10-Hanmer.pdf

Overview of Patterns Applied in the ImageStreamGang App

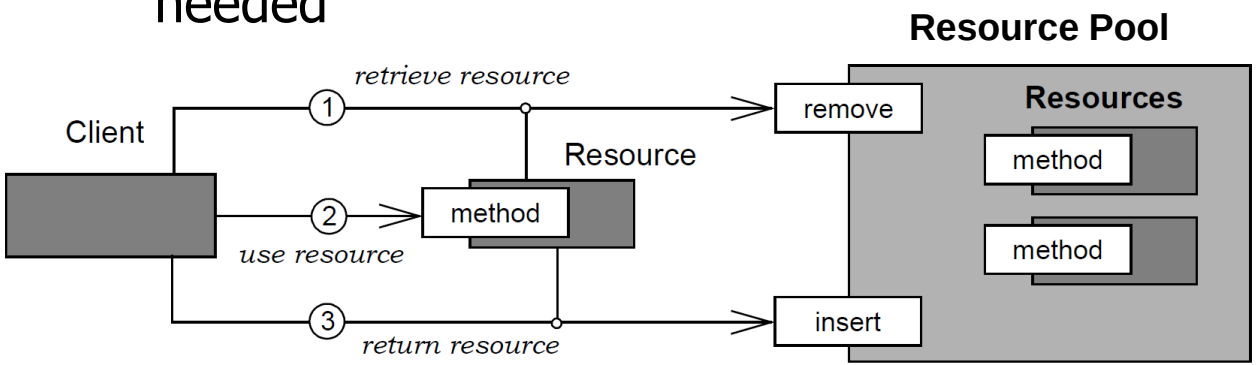
- Some patterns are essential to its design
  - *Future*
    - Provides a proxy to a client when it invokes a service to keep track of the state of the service's concurrent computation & only returns a value to the client when the computation completes



See en.wikipedia.org/wiki/Futures_and_promises

Overview of Patterns Applied in the ImageStreamGang App

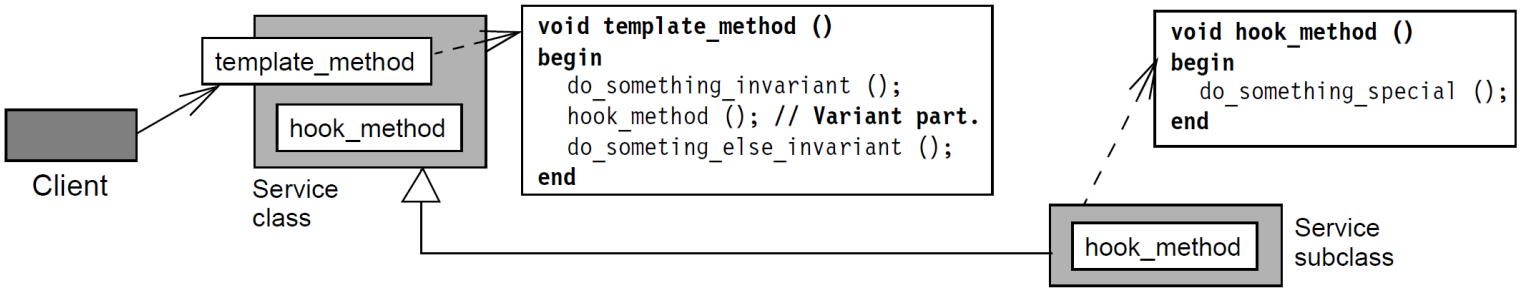
- Some patterns are essential to its design
  - *Resource Pool*
    - Prevents expensive acquisition & release of resources by recycling resources no longer needed

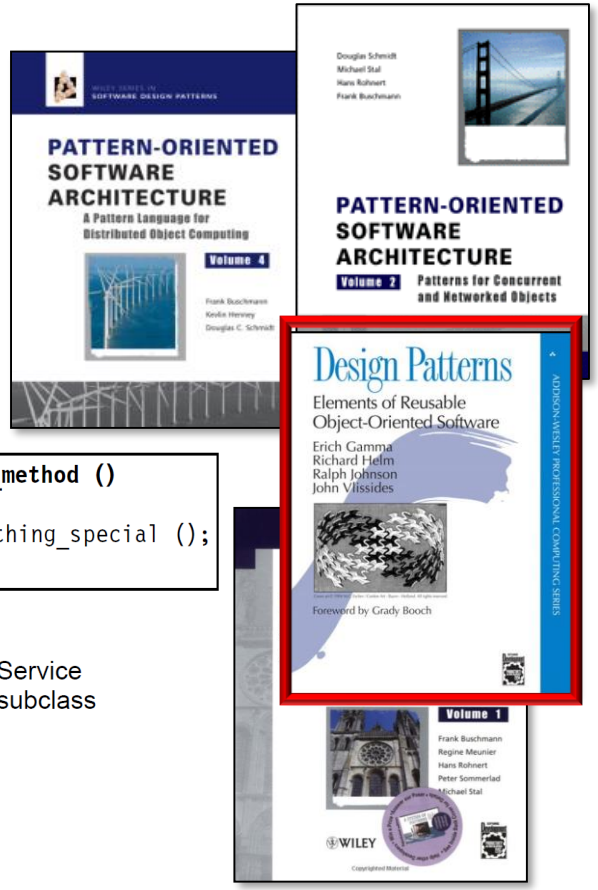


See kircher-schwanninger.de/michael/publications/Pooling.pdf

Overview of Patterns Applied in the ImageStreamGang App

- Some patterns are essential to its design
  - *Template Method*
    - Defines the overall structure of a method, while allowing subclasses to refine, or redefine, certain steps

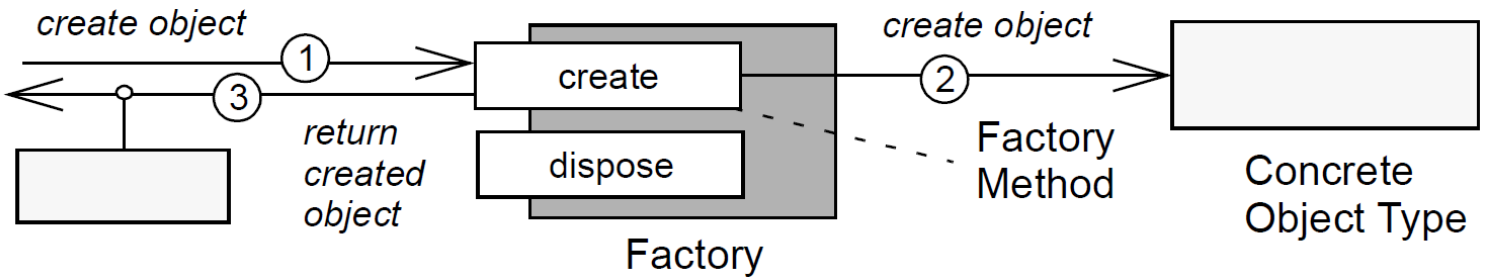




See en.wikipedia.org/wiki/Template_method_pattern

Overview of Patterns Applied in the ImageStreamGang App

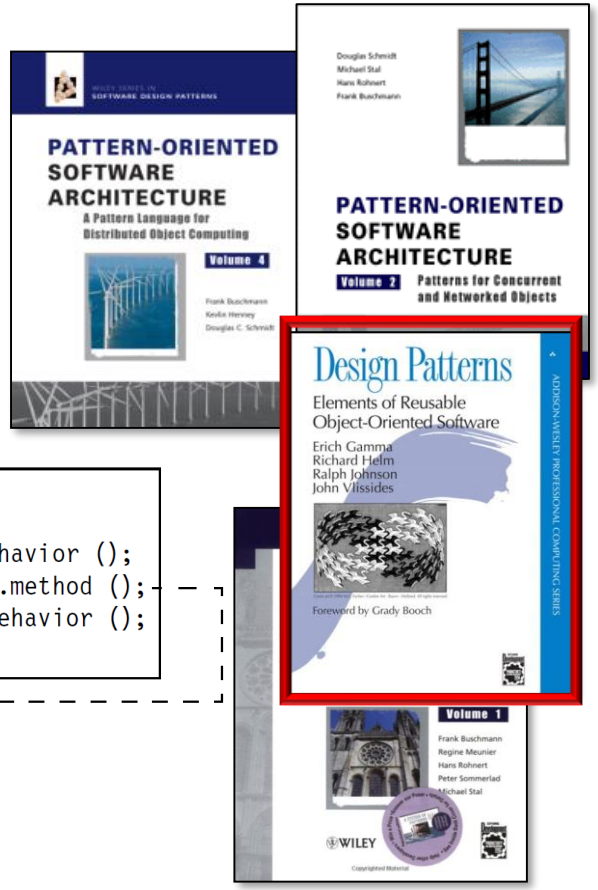
- Some patterns are essential to its design
  - *Factory Method*
    - Encapsulate the concrete details of object creation inside a factory method, rather than letting clients create the object themselves

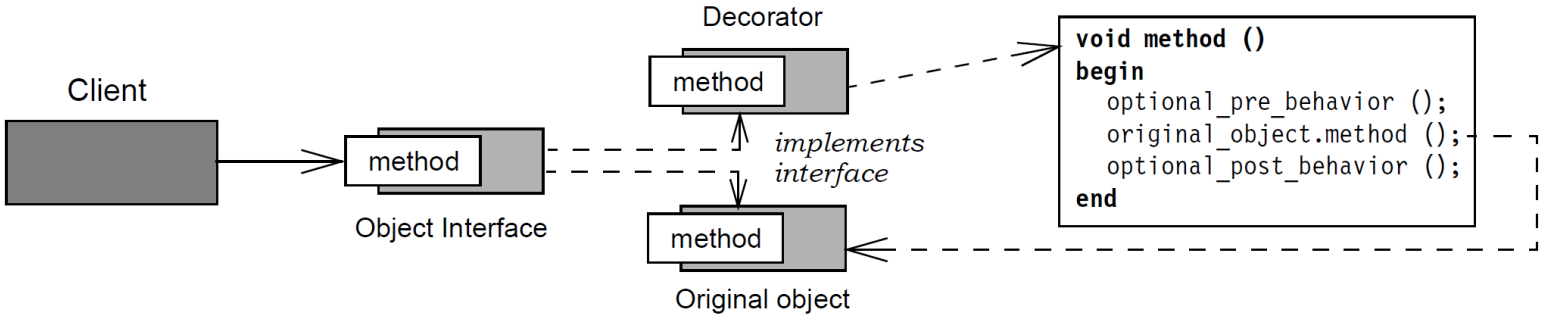


See en.wikipedia.org/wiki/Factory_method_pattern

Overview of Patterns Applied in the ImageStreamGang App

- Some patterns are essential to its design
  - *Decorator*
    - Allows behavior to be added to an individual object, dynamically, without affecting the behavior of other objects from the same class

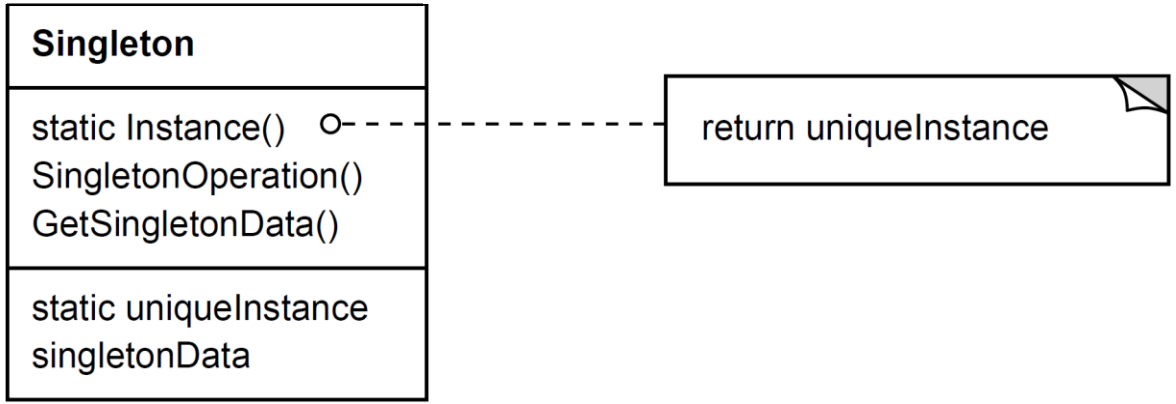




See en.wikipedia.org/wiki/Decorator_pattern

Overview of Patterns Applied in the ImageStreamGang App

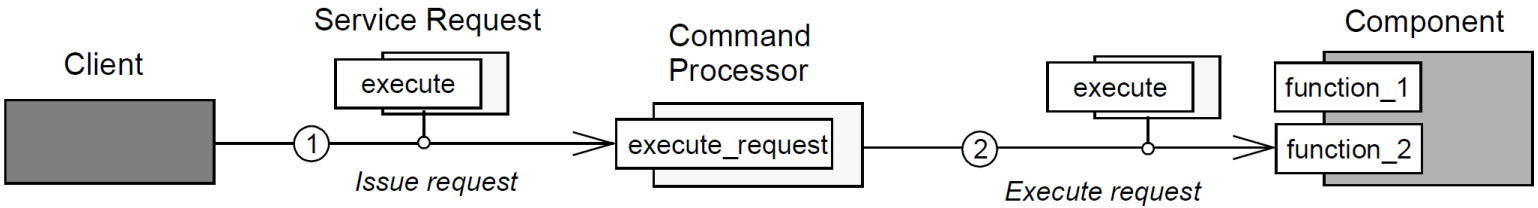
- Other patterns are also applied
  - *Singleton*
    - Ensure a class has only one instance & provide a global point of access to it



See en.wikipedia.org/wiki/Singleton_pattern

Overview of Patterns Applied in the ImageStreamGang App

- Other patterns are also applied
  - *Command Processor*
    - Packages a piece of application functionality—as well as its parameterization in an object—to make it usable in another context, such as later in time or in a different thread



See www.dre.vanderbilt.edu/~schmidt/CommandProcessor.pdf

Strategy for Understanding the ImageStreamGang App

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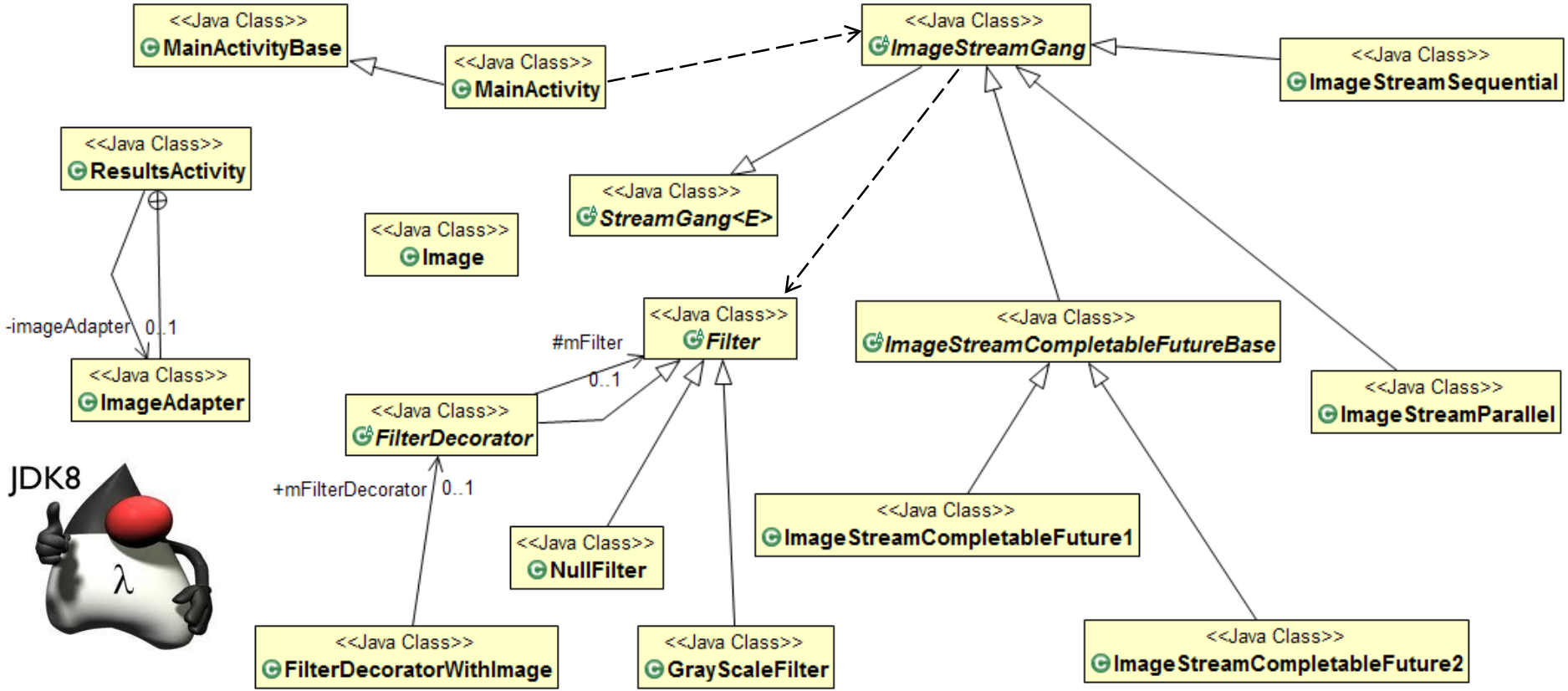
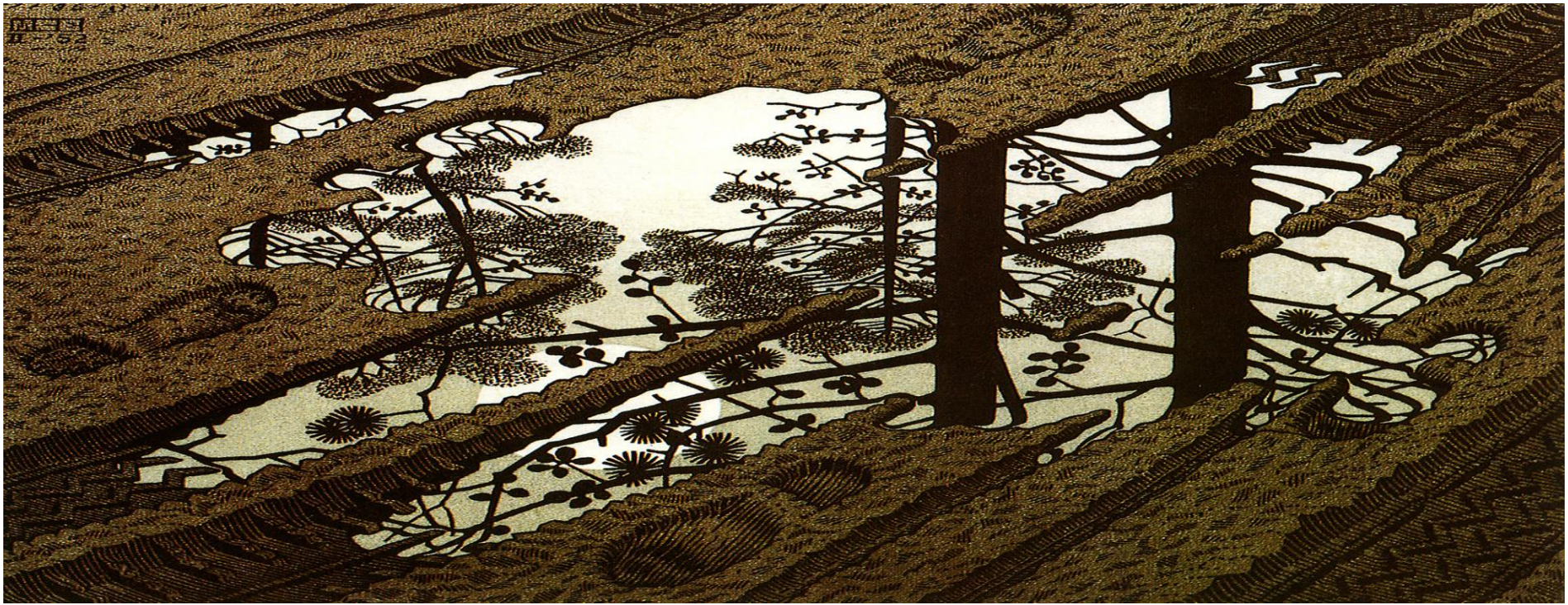
- This app is complicated & contains many classes



Strategy for Understanding the ImageStreamGang App

- This app is complicated & contains many classes
  - We therefore analyze it from various perspectives



Including pattern-oriented design, data flows, & detailed code walkthroughs

Strategy for Understanding the ImageStreamGang App

- This app is complicated & contains many classes
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  - Watch this entire lesson carefully to understand how it all works

Strategy for Understanding the ImageStreamGang App

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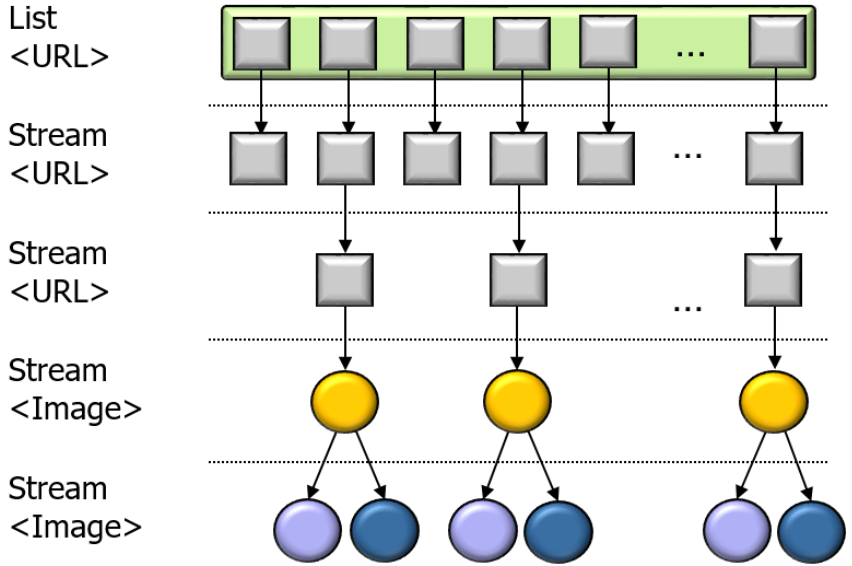
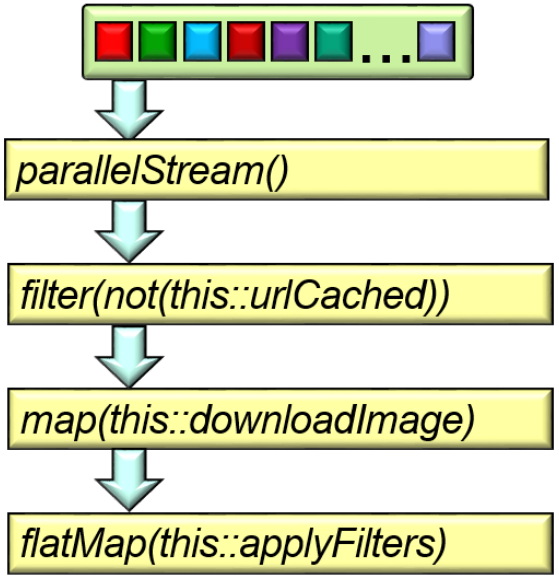
  - Visualize the data flow in a parallel stream





Strategy for Understanding the ImageStreamGang App

- This app is complicated & contains many classes
  - We therefore analyze it from various perspectives
  - Watch this entire lesson carefully to understand how it all works
  - Visualize the data flow in a parallel stream
  - Run/read the code to see how it all works

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

End of Java Parallel ImageStreamGang Example: Introduction