Applying Java Functional Programming Features: Evaluating Pros & Cons

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Learning Objectives in this Lesson

- Understand how Java functional programming features are applied in a simple parallel program
- Know how to start & join Java threads via functional programming features
- Appreciate the pros & cons of using Java features in this example

These "cons" motivate the need for Java function parallelism frameworks

Pros of the ThreadJoinTest Program

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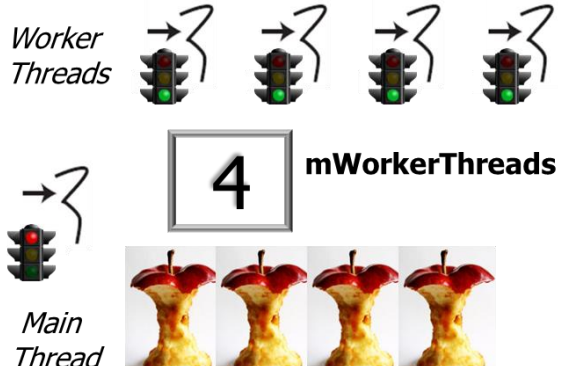
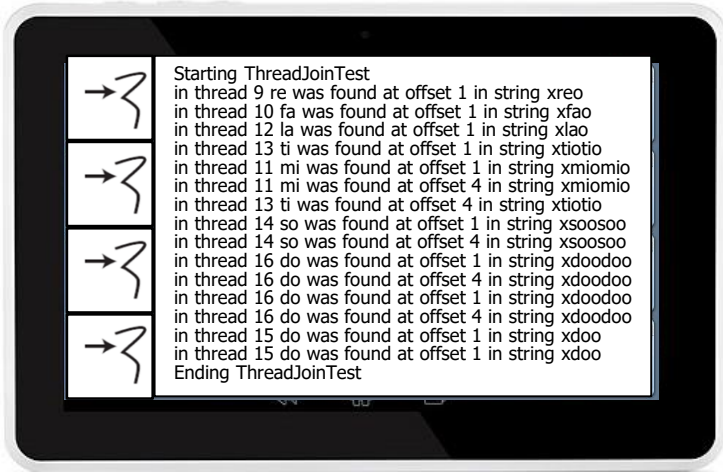
- Foundational Java FP features improve the program vis-à-vis original OO Java version





See github.com/douglascraigschmidt/LiveLessons/tree/master/ThreadJoinTest/original

Pros of the ThreadJoinTest Program

- Foundational Java FP features improve the program vis-à-vis original OO Java version, e.g.
  - The OO Java version has more syntax & traditional for loops

```
for (int i = 0;
     i < mInput.size(); ++i) {
  Thread t = new Thread
    (makeTask(i));

  mWorkerThreads.add(t);
}
...
Runnable makeTask(int i) {
  return new Runnable() {
    public void run() {
      String e = mInput.get(i);
      processInput(e);
    }
  ...
```

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Index-based for loops often suffer from "off-by-one" errors

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See en.wikipedia.org/wiki/Off-by-one_error

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Anonymous inner classes are tedious to write..

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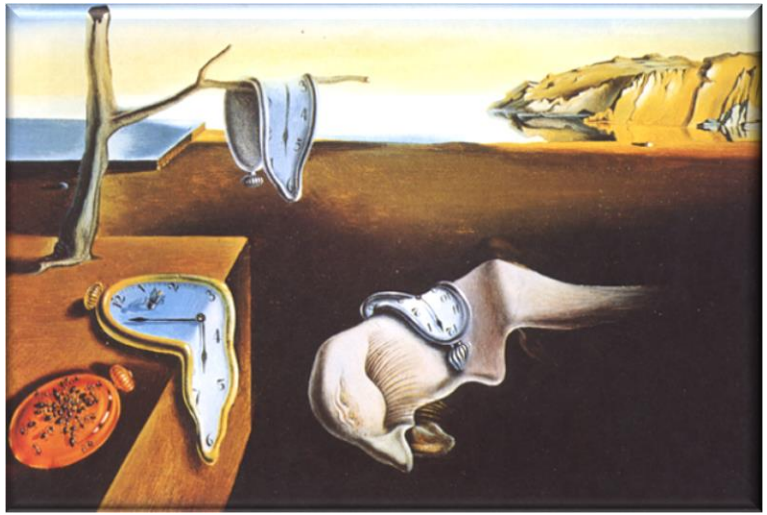

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Runnable makeTask(int i) {
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      processInput(e);
    }
  ...
```

The OO Java version is thus more tedious & error-prone to program..

Pros of the ThreadJoinTest Program

- Foundational Java FP features improve the program vis-à-vis original OO Java version, e.g.
  - The OO Java version has more syntax & traditional for loops
  - The FP Java implementation is more concise, extensible, & robust

```
public void run() {
  List<Thread> workerThreads =
    makeWorkerThreads
      (this::processInput);

  workerThreads
    .forEach(Thread::start);
  ...
```

```
List<Thread> makeWorkerThreads
  (Function<String, Void> task) {
  ...
  mInputList.forEach(input ->
    workerThreads.add
      (new Thread(() -> task.apply(input))));
```

e.g., declarative Java features such as forEach(), functional interfaces, method references, & lambda expressions

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The forEach() method avoids "off-by-one" fence-post errors

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List<Thread> makeWorkerThreads
  (Function<String, Void> task) {
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```

Functional interfaces, method references, & lambda expressions simplify behavioral parameterization

Cons of the ThreadJoinTest Program

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- There's still "accidental complexity" in the Java FP version

Accidental complexities arise from limitations with software techniques, tools, & methods

See en.wikipedia.org/wiki/No_Silver_Bullet

Cons of the ThreadJoinTest Program

- There's still "accidental complexity" in the Java FP version, e.g.
  - Manually creating, starting, & joining threads

You must remember to start each thread!

```
public void run() {
  List<Thread> workerThreads =
    makeWorkerThreads
      (this::processInput);

  workerThreads
    .forEach(Thread::start);

  workerThreads
    .forEach(thread -> {
      try { thread.join(); }
      catch(Exception e) {
        throw new
         RuntimeException(e);
      }}); ...
```

Cons of the ThreadJoinTest Program

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      catch(Exception e) {
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      }}); ...
```

Note the verbosity of handling checked exceptions in Java 8 programs..

See codingjunkie.net/functional-iterface-exceptions

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  - Manually creating, starting, & joining threads

```
public void run() {
  List<Thread> workerThreads =
    makeWorkerThreads
      (this::processInput);

  workerThreads
    .forEach(Thread::start);

  workerThreads
    .forEach(rethrowConsumer
               (Thread::join));
```

A helper class enables less verbosely use of checked exceptions in Java FP programs

See stackoverflow.com/a/27644392/3312330

Cons of the ThreadJoinTest Program

- There's still "accidental complexity" in the Java FP version, e.g.
  - Manually creating, starting, & joining threads
  - Only one parallelism model supported
    - "thread-per-work" hard-codes the # of threads to # of input strings

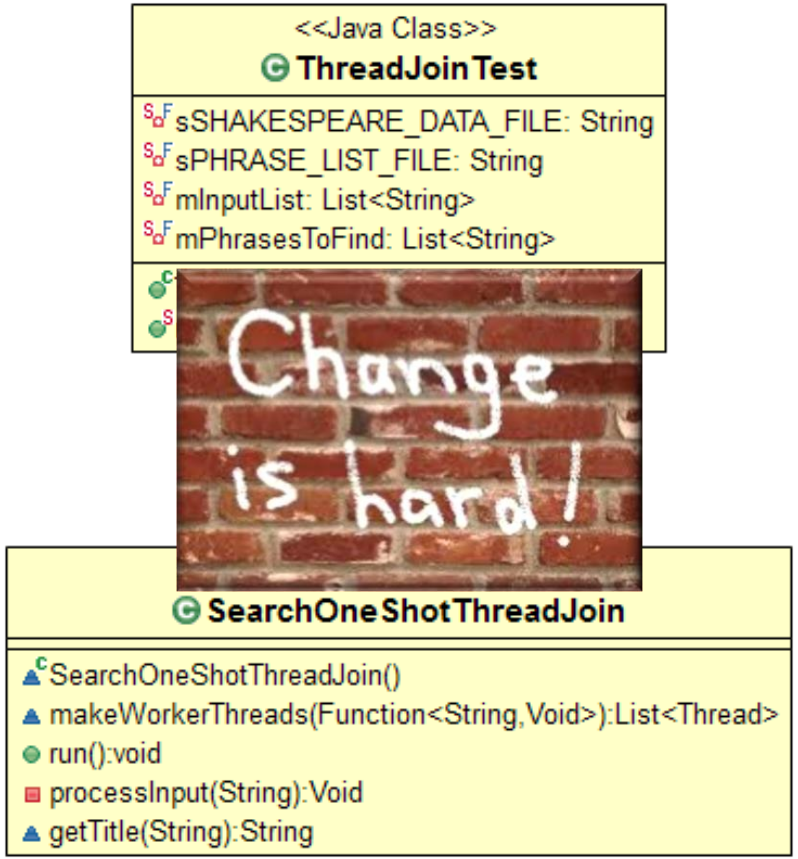
```
List<Thread> makeWorkerThreads
   (Function<String, Void> task){
   List<Thread> workerThreads =
     new ArrayList<>();

   mInputList.forEach(input ->
     workerThreads.add
       (new Thread(()
          -> task.apply(input))));

   return workerThreads;
}
```

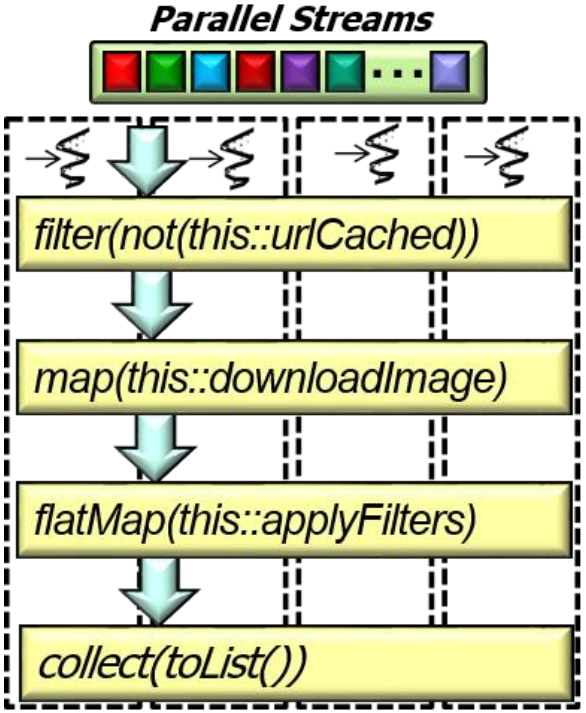
Cons of the ThreadJoinTest Program

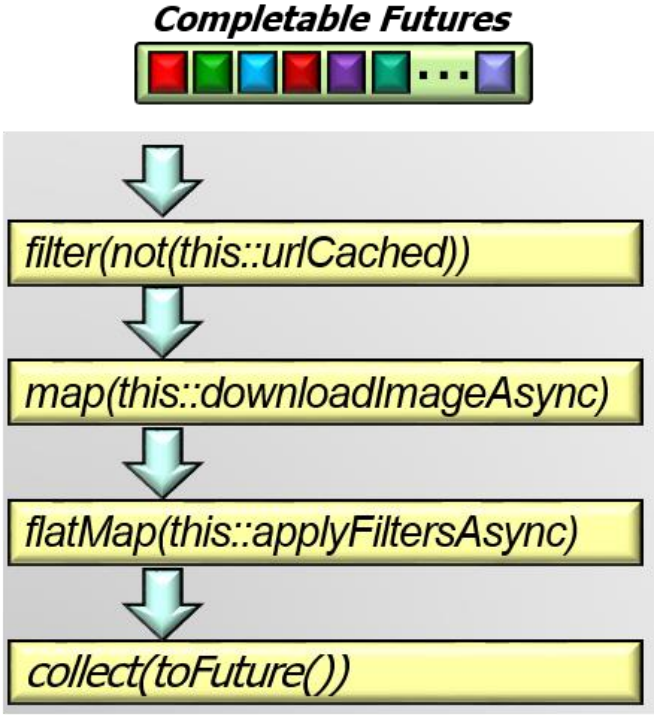
- There's still "accidental complexity" in the Java FP version, e.g.
  - Manually creating, starting, & joining threads
  - Only one parallelism model supported
  - Not easily extensible without major changes to the code
    - e.g., insufficiently declarative



Cons of the ThreadJoinTest Program

- Solving these problems requires more than the foundational Java FP features





See www.dre.vanderbilt.edu/~schmidt/DigitalLearning

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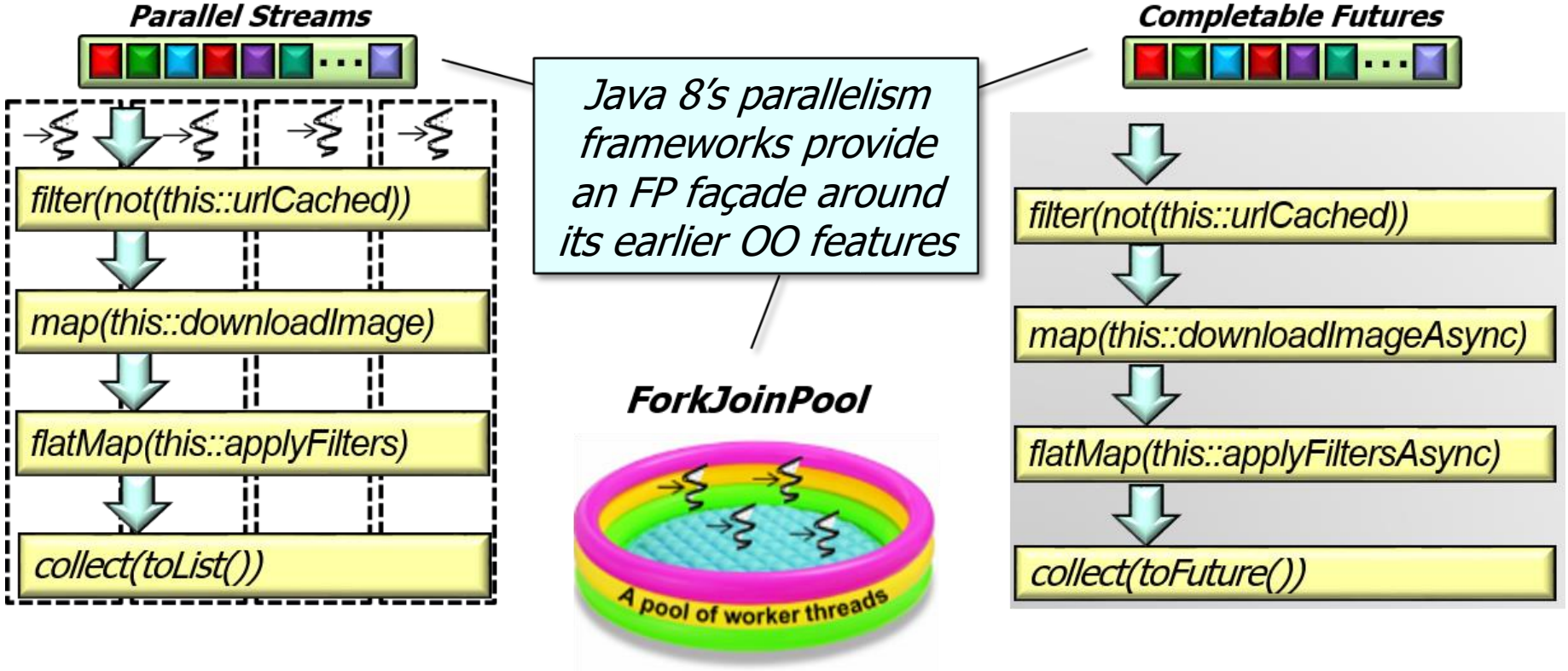

See en.wikipedia.org/wiki/Facade_pattern

End of Applying Java Functional Programming Features: Evaluating Pros & Cons