Applying Foundational Java 8 Features to a Concurrent Program

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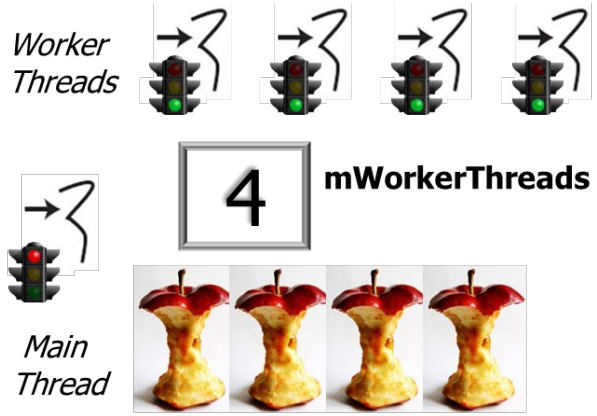
Learning Objectives in this Lesson

- Understand how foundational Java 8 functional programming features are applied in the ThreadJoinTest program



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

Learning Objectives in this Lesson

- Understand how foundational Java 8 functional programming features are applied in the ThreadJoinTest program
- Recognize the pros & cons of using Java 8 features in this example

Example of Starting & Joining Java Threads with Java 8

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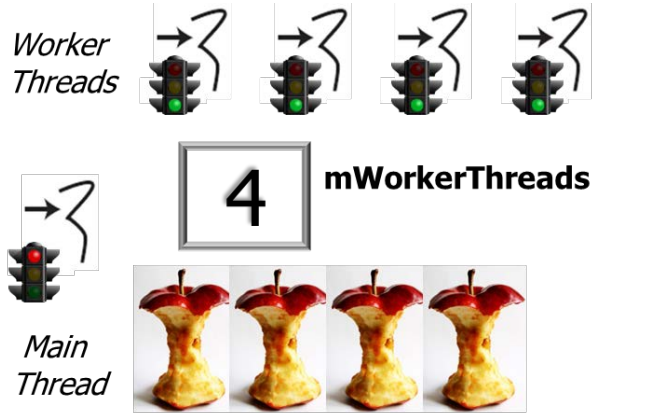
- Use Java 8 features to start() & join() a group of threads to search for phrases in the works of William Shakespeare

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

workerThreads
   .forEach(thread ->
     { try { thread.join(); }
     catch (InterruptedException e)
     { ... }});
```



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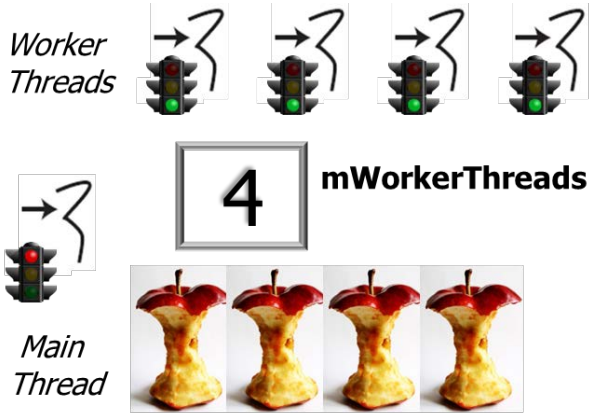
Example of Starting & Joining Java Threads with Java 8

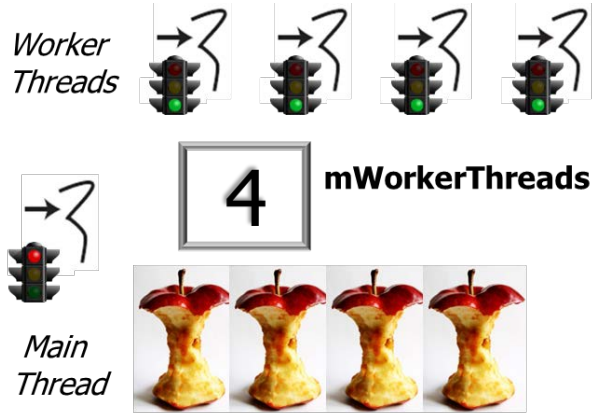
- This program is "embarrassingly parallel"



See en.wikipedia.org/wiki/Embarrassingly_parallel

Example of Starting & Joining Java Threads with Java 8

- This program is "embarrassingly parallel"
  - i.e., there are no data dependencies between worker threads



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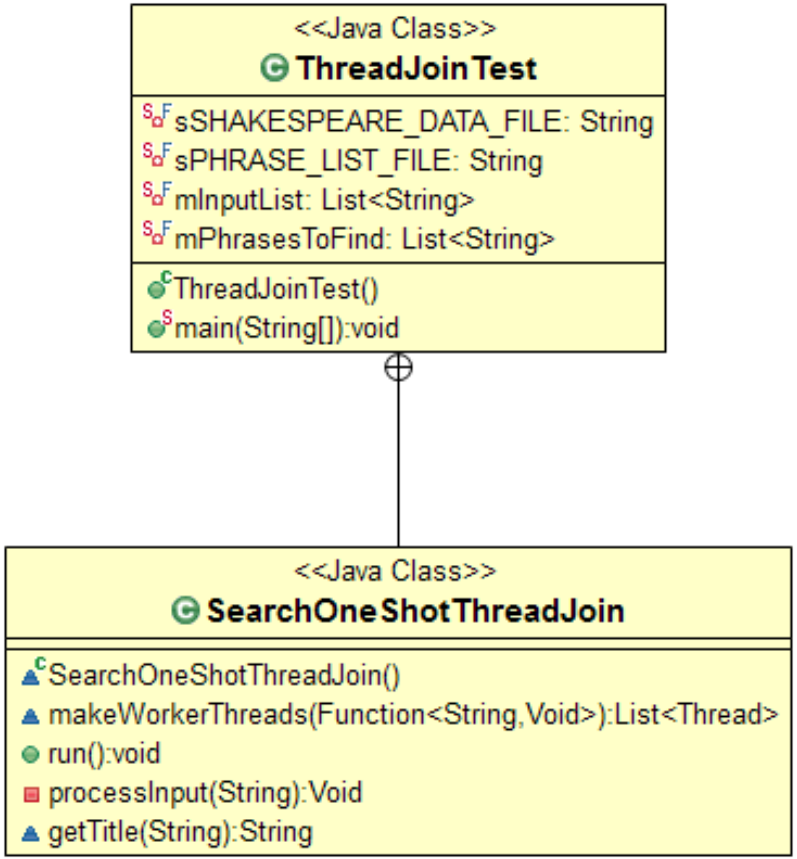
Example of Starting & Joining Java Threads with Java 8

- There are several foundational Java 8 features to note



Example of Starting & Joining Java Threads with Java 8

- There are several foundational Java 8 features to note, e.g.,
  - Create/start worker threads via forEach() & a method reference

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

  workerThreads
    .forEach(Thread::start);

  ...
```

forEach() & method reference

Example of Starting & Joining Java Threads with Java 8

- There are several foundational Java 8 features to note, e.g.,
  - Create/start worker threads via forEach() & a method reference
  - Pass a method reference to a method expecting a functional interface

The use of a functional interface makes it easier to change that function is passed

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

  ...

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

Void processInput(String input) {
  ...
}
```

Example of Starting & Joining Java Threads with Java 8

- There are several foundational Java 8 features to note, e.g.,
  - Create/start worker threads via forEach() & a method reference
  - Pass a method reference to a method expecting a functional interface
  - Apply a function lambda to create the runnable processed by a thread

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

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

  return workerThreads;
}
```

Example of Starting & Joining Java Threads with Java 8

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  - Create/start worker threads via forEach() & a method reference
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       ... thread.join(); ...
     } ...
```

Uses forEach() & lambda expression

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Simple form of barrier synchronization

No other Java synchronization mechanisms are needed!

Pros of the ThreadJoinTest Program

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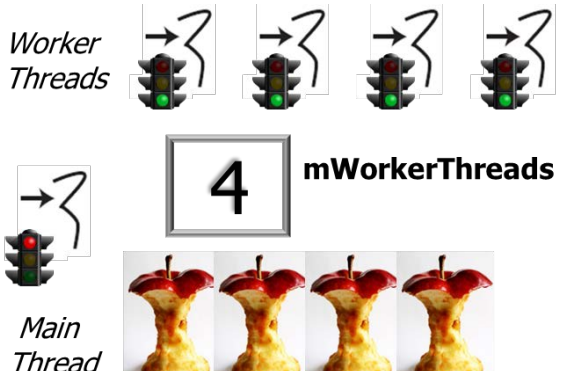
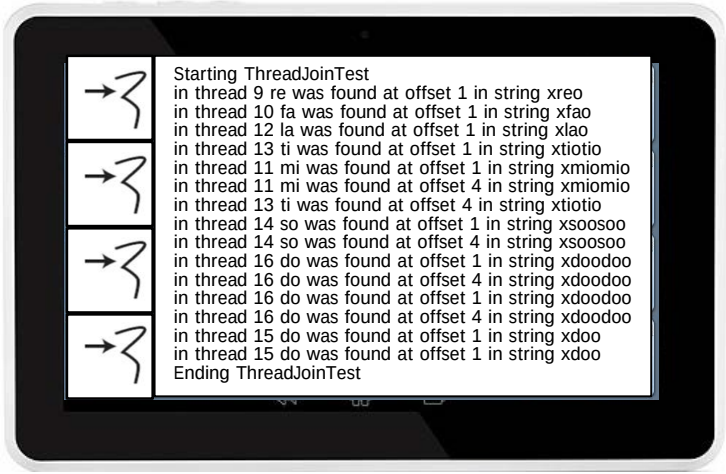
- Using foundational Java 8 features improves the program vis-à-vis original Java 7 version





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

Pros of the ThreadJoinTest Program

- Using foundational Java 8 features improves the program vis-à-vis original Java 7 version, e.g.
  - The Java 7 version has additional 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(element);
    }
  ...
```

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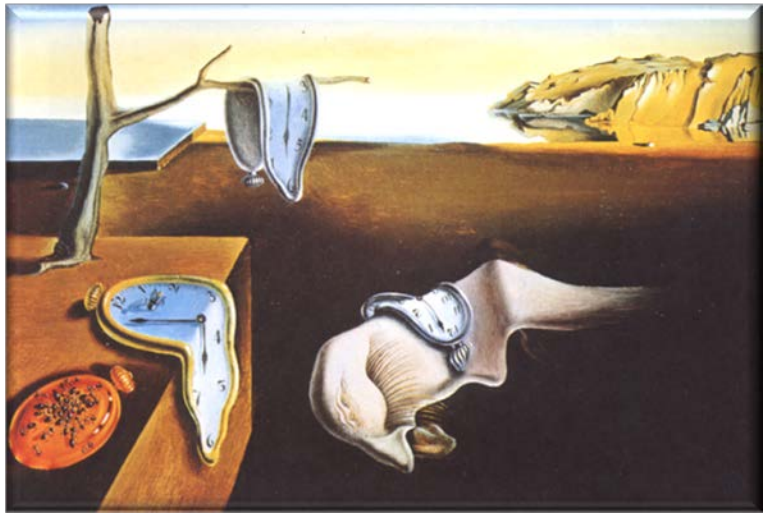

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Runnable makeTask(int i) {
  return new Runnable() {
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      String e = mInput.get(i);
      processInput(element);
    }
  ...
```

The Java 7 version is thus more tedious & error-prone to program..

Pros of the ThreadJoinTest Program

- Using foundational Java 8 features improves the program vis-à-vis original Java 7 version, e.g.
  - The Java 7 version has additional syntax & traditional for loops
  - The Java 8 implementation is a bit more concise & extensible
    - Due to functional interfaces & basic declarative features

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

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

  mInputList.forEach(input ->
    workerThreads.add
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```

Cons of the ThreadJoinTest Program

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- There's still "accidental complexity" in the Java 8 version

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

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  - Manually creating/joining threads

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       ... thread.join(); ...
     } ...
```

Cons of the ThreadJoinTest Program

- There's still "accidental complexity" in the Java 8 version, e.g.
  - Manually creating/joining threads
  - Only one concurrency model supported
    - "thread-per-input" that hard-codes the # of threads to match the # of input strings

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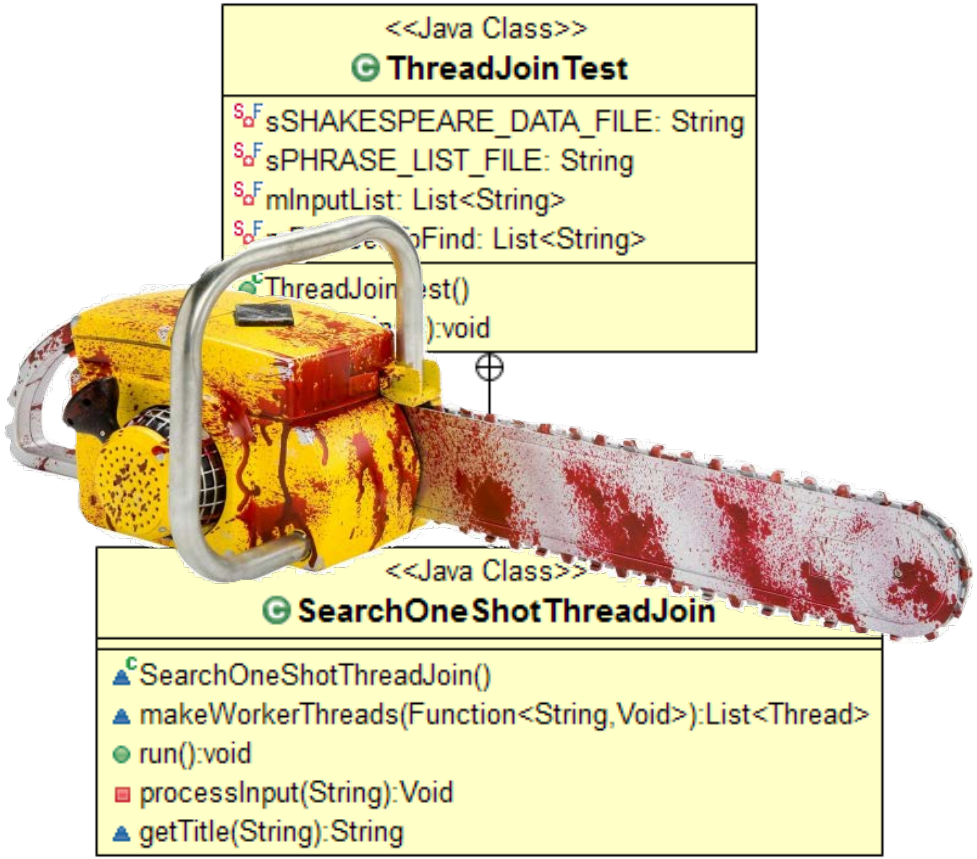
```

Cons of the ThreadJoinTest Program

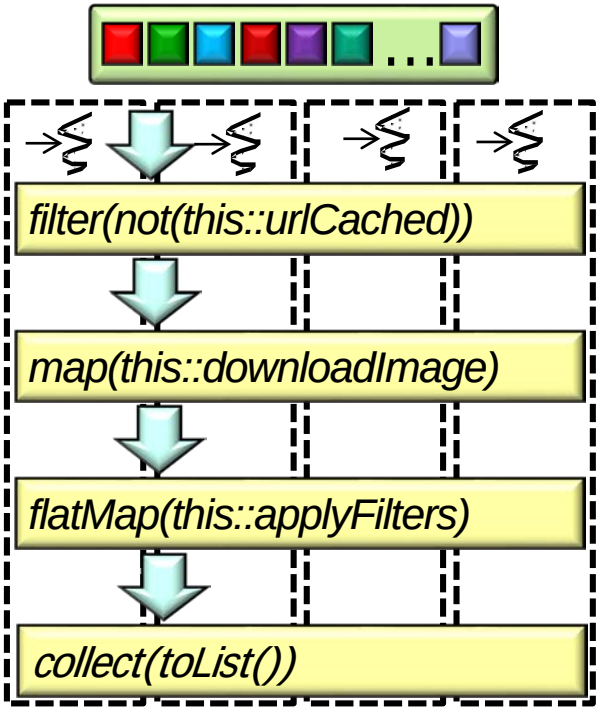
- There's still "accidental complexity" in the Java 8 version, e.g.
  - Manually creating/joining threads
  - Only one concurrency model supported
  - Not easily extensible without major changes to the code
    - e.g., insufficiently declarative



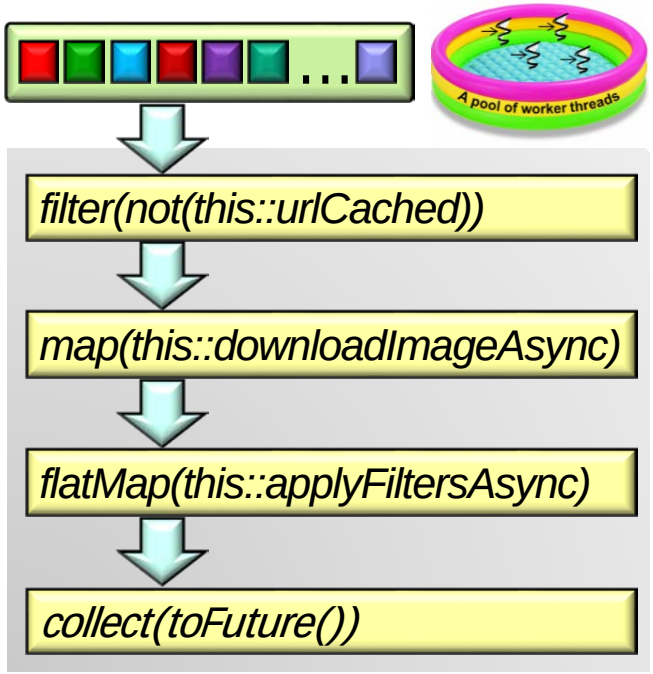
Cons of the ThreadJoinTest Program

- Solving these problems requires more than the foundational Java 8 features

Parallel Streams



Completable Futures



End of Applying Foundational Java 8 Features