

# Applying Java Functional Programming Features: Introduction

**Douglas C. Schmidt**

**[d.schmidt@vanderbilt.edu](mailto:d.schmidt@vanderbilt.edu)**

**[www.dre.vanderbilt.edu/~schmidt](http://www.dre.vanderbilt.edu/~schmidt)**



**Professor of Computer Science**

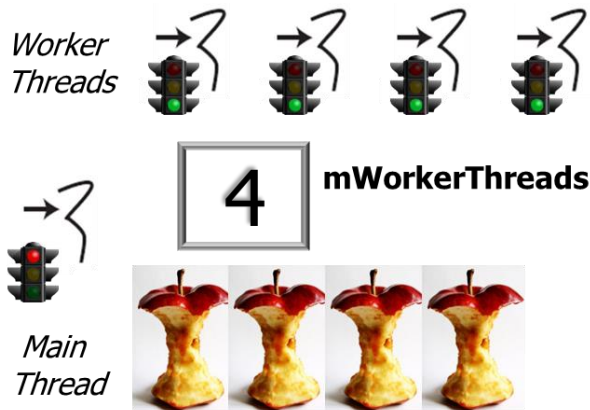
**Institute for Software  
Integrated Systems**

**Vanderbilt University  
Nashville, Tennessee, USA**



# Learning Objectives in this Part of the Lesson

- Understand how Java functional programming features are applied in a simple parallel program



```
Starting SearchStream
in thread 23 the phrase "Anon," was found at character offset 111628 in "The First Part of Henry VI"
in thread 20 the phrase "Anon," was found at character offset 30949 in "The First Part of King Henry IV"
in thread 20 the phrase "Anon," was found at character offset 48850 in "The First Part of King Henry IV"
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in thread 40 the phrase "Anon," was found at character offset 46837 in "The Tragedy of Romeo & Juliet"
Ending SearchStream
```

See [github.com/douglasraigschmidt/LiveLessons/tree/master/ThreadJoinTest/updated](https://github.com/douglasraigschmidt/LiveLessons/tree/master/ThreadJoinTest/updated)

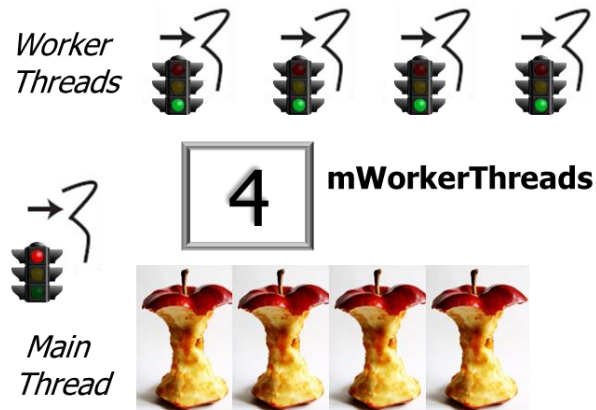
# Learning Objectives in this Part of the Lesson

- Understand how Java functional programming features are applied in a simple parallel program
- This program searches for a list of phrases in the complete works of William Shakespeare

## The Complete Works of William Shakespeare



Welcome to the Web's first edition of the Complete Works of William Shakespeare. This site has offered Shakespeare's plays and poetry to the Internet community since 1993.



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Ending SearchStream
```

See [shakespeare.mit.edu](http://shakespeare.mit.edu)

---

# Overview of the ThreadJoinTest Program

# Overview of the ThreadJoinTest Program

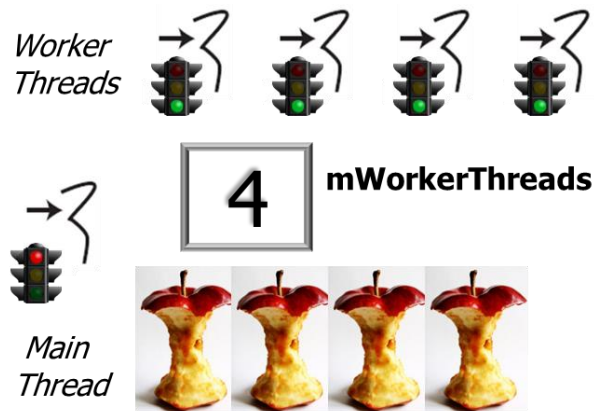
- Use Java functional programming features to start() & join() threads to search for phrases in works of William Shakespeare

`workerThreads`

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

`workerThreads`

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

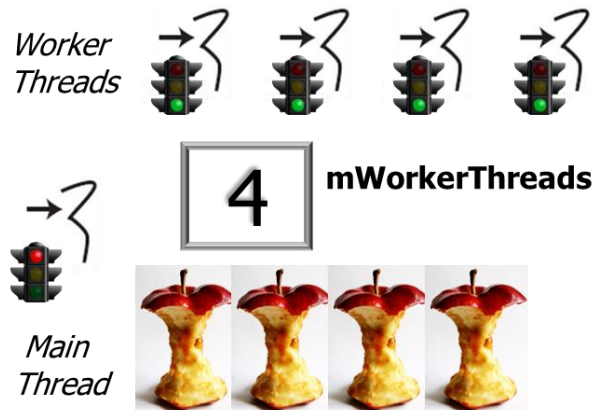
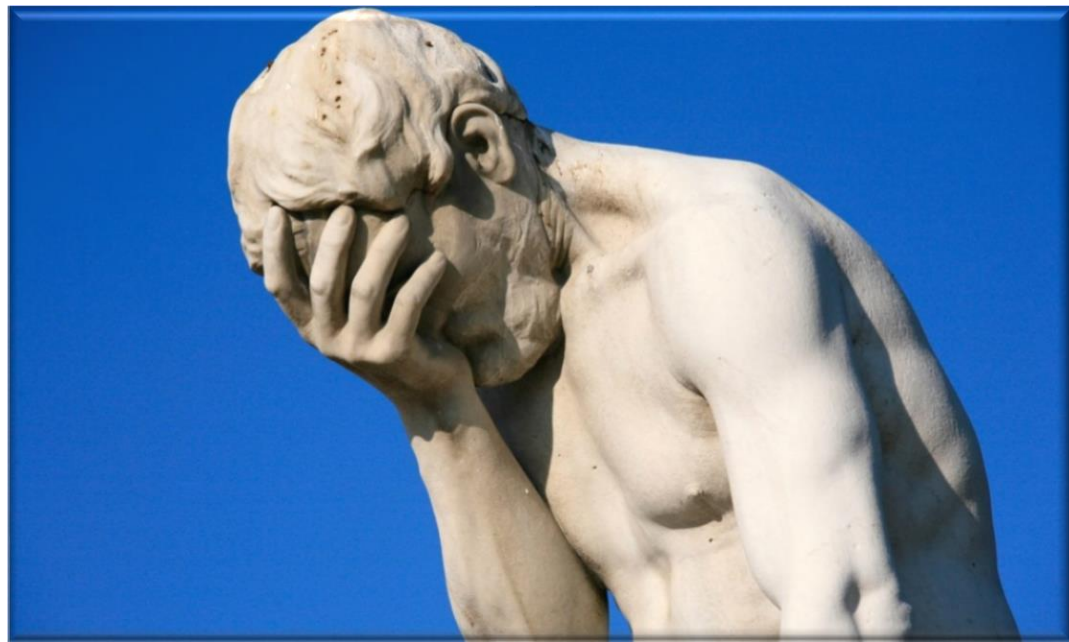


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Ending SearchStream
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See [github.com/douglasraigschmidt/LiveLessons/tree/master/ThreadJoinTest/updated](https://github.com/douglasraigschmidt/LiveLessons/tree/master/ThreadJoinTest/updated)

# Overview of the ThreadJoinTest Program

- This program is "embarrassingly parallel"



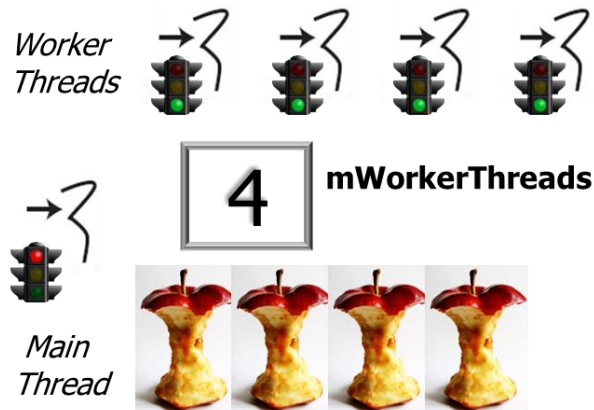
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Ending SearchStream
```

See [en.wikipedia.org/wiki/Embarrassingly\\_parallel](https://en.wikipedia.org/wiki/Embarrassingly_parallel)



# Overview of the ThreadJoinTest Program

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



```
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Ending SearchStream
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See [en.wikipedia.org/wiki/Embarrassingly\\_parallel](https://en.wikipedia.org/wiki/Embarrassingly_parallel)

# Overview of the ThreadJoinTest Program

- The program obtains the complete works of Shakespeare & a list of phrases from two text files

```
List<String> mInputList =  
    TestDataFactory.getInput  
        (sSHAKESPEARE_DATA_FILE,  
         "@") ;
```

...

@The Tragedy of Hamlet

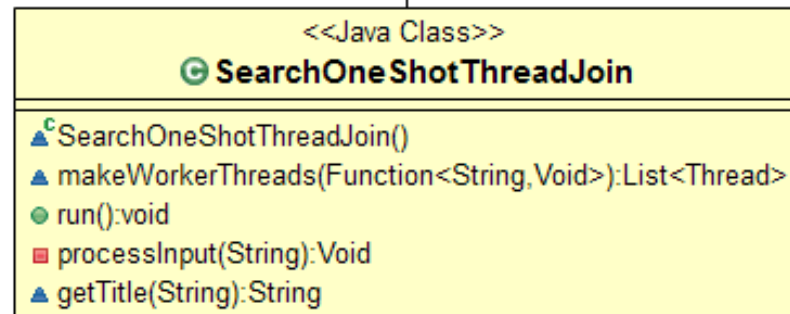
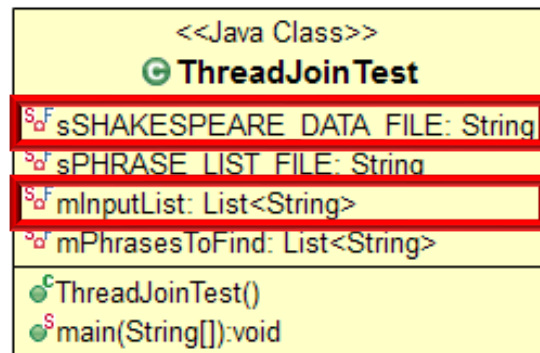
...

@The Tragedy of Julius Caesar

...

@The Tragedy of Macbeth

...



Each work begins with a '@' character



# Overview of the ThreadJoinTest Program

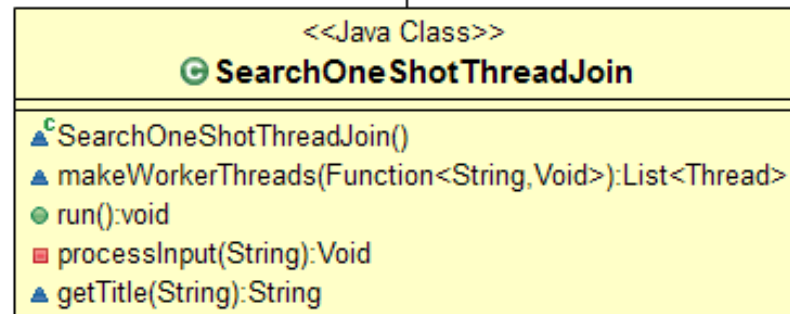
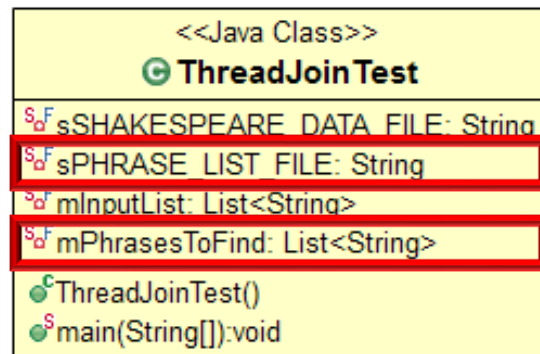
- The program obtains the complete works of Shakespeare & a list of phrases from two text files

```
List<String> mPhrasesToFind =  
    TestDataFactory.getPhraseList  
        (sPHRASE_LIST_FILE);
```

...

```
Neither a borrower nor a lender be  
Beware the Ides of March  
Brevity is the soul of wit  
All that glisters is not gold  
Sit you down, father; rest you  
my kingdom for a horse!
```

...



Each phrase appears on a separate line

# Overview of the ThreadJoinTest Program

---

- Return the input data in the given file as a list of non-empty strings

```
static List<String> getInput(String file, String splitter) {  
    URI uri = ClassLoader.getResource(file).toURI();  
  
    String bytes = new String(Files.readAllBytes  
                                (Paths.get(uri)));  
  
    return Pattern  
        .compile(splitter)  
        .splitAsStream(bytes)  
        .filter(((Predicate<String>) String::isEmpty).negate())  
        .collect(toList());  
}
```

---

These methods also demonstrate some Java 8 streams features!

# Overview of the ThreadJoinTest Program

---

- Return the input data in the given file as a list of non-empty strings

```
static List<String> getInput(String file, String splitter) {  
    URI uri = ClassLoader.getResource(file).toURI();
```

*Convert the file name into a path name*

```
    String bytes = new String(Files.readAllBytes  
                                (Paths.get(uri)));
```

```
    return Pattern  
        .compile(splitter)  
        .splitAsStream(bytes)  
        .filter(((Predicate<String>) String::isEmpty).negate())  
        .collect(toList());
```

```
}
```

# Overview of the ThreadJoinTest Program

---

- Return the input data in the given file as a list of non-empty strings

```
static List<String> getInput(String file, String splitter) {  
    URI uri = ClassLoader.getResource(file).toURI();
```

```
    String bytes = new String(Files.readAllBytes  
                               (Paths.get(uri)));
```

*Open the file & read all the bytes*



```
    return Pattern  
        .compile(splitter)  
        .splitAsStream(bytes)  
        .filter(((Predicate<String>) String::isEmpty).negate())  
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}
```

# Overview of the ThreadJoinTest Program

- Return the input data in the given file as a list of non-empty strings

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```
    String bytes = new String(Files.readAllBytes  
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```

```
    return Pattern
```

```
        .compile(splitter)
```

```
        .splitAsStream(bytes)
```

```
        .filter(((Predicate<String>) String::isEmpty).negate())
```

```
        .collect(toList());
```

```
}
```

*Compile a regular expression used to split the file into a stream of strings*

# Overview of the ThreadJoinTest Program

---

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```
    String bytes = new String(Files.readAllBytes  
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```

```
    return Pattern
```

```
        .compile(splitter)
```

```
        .splitAsStream(bytes)
```

```
        .filter((Predicate<String>) String::isEmpty).negate())
```

```
        .collect(toList());
```

```
}
```

*Filter out any empty strings in the stream*





# Overview of the ThreadJoinTest Program

---

- Return the input data in the given file as a list of non-empty strings

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static List<String> getInput(String file, String splitter) {  
    URI uri = ClassLoader.getResource(file).toURI();
```

```
    String bytes = new String(Files.readAllBytes  
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```

```
    return Pattern  
        .compile(splitter)  
        .splitAsStream(bytes)  
        .filter(((Predicate<String>) String::isEmpty).negate())  
        .collect(toList());
```

```
}
```

*Collect the results into a list of strings*

# Overview of the ThreadJoinTest Program

---

- Return the phrase list in the file as a list of non-empty strings

```
static List<String> getPhraseList(String file) {  
    return Files  
        .lines(Paths  
            .get(ClassLoader.getResource(file).toURI()))  
  
        .filter(((Predicate<String>) String::isEmpty).negate())  
  
        .collect(toList());  
}
```

# Overview of the ThreadJoinTest Program

---

- Return the phrase list in the file as a list of non-empty strings

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*Read all lines from file into a stream*

# Overview of the ThreadJoinTest Program

---

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```



*Filter out any empty strings in the stream*

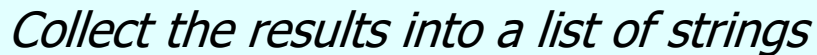
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        .filter(((Predicate<String>) String::isEmpty).negate())  
  
        .collect(toList());  
}
```

# Overview of the ThreadJoinTest Program

---

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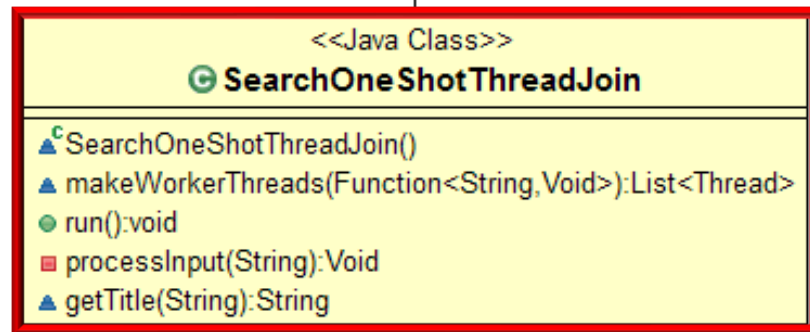
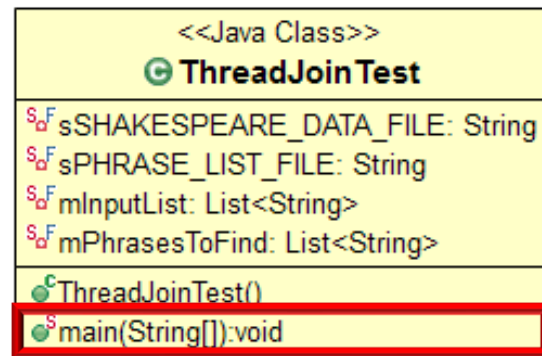
*Collect the results into a list of strings*

# Overview of the ThreadJoinTest Program

- The main program creates & runs an instance of SearchOneShotThreadJoin

```
public void main(String[] args) {  
    new SearchOneShotThreadJoin()  
        .run();  
}
```

*Create/run an object to search  
for all phrases in parallel*



See [ThreadJoinTest/updated/src/main/java/ThreadJoinTest.java](https://github.com/ThreadJoinTest/updated/src/main/java/ThreadJoinTest.java)



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# End of Applying Java Functional Programming Features: Introduction