Evaluating the Pros & Cons of Java Futures

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Learning Objectives in this Part of the Lesson

• Motivate the need for Java futures by understanding the pros & cons of synchrony & asynchrony

• Know how Java futures provide the foundation for completable futures in Java

• Understand how to multiply BigFraction objects concurrently via Java futures

• Motivate the need for Java completable futures by evaluating the pros & cons with Java futures
The Pros of Java Futures
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• Pros of async calls with Java futures
The Pros of Java Futures

- Pros of async calls with Java futures
- May leverage parallelism more effectively with fewer threads

See github.com/douglascraigschmidt/LiveLessons/tree/master/SearchTaskGang
The Pros of Java Futures

- Pros of async calls with Java futures
- May leverage parallelism more effectively with fewer threads, e.g.,
- Queue async computations for execution in a pool of threads

```java
mCompletionService
  .submit(() -> searchForWord(word, input));
```

See docs.oracle.com/javase/8/docs/api/java/util/concurrent/ExecutorCompletionService.html#submit
The Pros of Java Futures

- Pros of async calls with Java futures
- May leverage parallelism more effectively with fewer threads, e.g.,
  - Queue async computations for execution in a pool of threads
- Automatically tune # of threads

See [docs.oracle.com/javase/8/docs/api/java/util/concurrent/Executors.html#newCachedThreadPool](docs.oracle.com/javase/8/docs/api/java/util/concurrent/Executors.html#newCachedThreadPool)
The Pros of Java Futures

- Pros of async calls with Java futures
- May leverage parallelism more effectively with fewer threads, e.g.,
  - Queue async computations for execution in a pool of threads
  - Automatically tune # of threads
- Results can be taken from queue of completed futures

Future<SearchResults> resultF = mCompletionService.take();

take() blocks, but get() doesn’t

resultF.get().print()

See docs.oracle.com/javase/8/docs/api/java/util/concurrent/ExecutorCompletionService.html#take
The Pros of Java Futures

- Pros of async calls with Java futures
- May leverage parallelism more effectively with fewer threads
- Can block until the result of an async two-way task is available

```java
String f1 = "62675744/15668936";
String f2 = "609136/913704";

Future<BigFraction> f =
    commonPool().submit(() -> {
        BigFraction bf1 =
            new BigFraction(f1);
        BigFraction bf2 =
            new BigFraction(f2);
        return bf1.multiply(bf2);
    });

BigFraction result =
    f.get();
```
The Pros of Java Futures

- Pros of async calls with Java futures
  - May leverage parallelism more effectively with fewer threads
  - Can block until the result of an async two-way task is available
  - Can also poll or time-wait

```java
String f1 = "62675744/15668936";
String f2 = "609136/913704";

Future<BigFraction> f =
    commonPool().submit(() -> {
        BigFraction bf1 =
            new BigFraction(f1);
        BigFraction bf2 =
            new BigFraction(f2);
        return bf1.multiply(bf2);
    });

BigFraction result =
    f.get(n, MILLISECONDS);
```

May help to make an asynchronous program more responsive
The Pros of Java Futures

- Pros of async calls with Java futures
  - May leverage parallelism more effectively with fewer threads
  - Can block until the result of an async two-way task is available
  - Can be canceled & tested to see if a task is done or cancelled

```
String f1 = "62675744/15668936";
String f2 = "609136/913704";

Future<BigFraction> f =
    commonPool().submit(() -> { 
        BigFraction bf1 =
            new BigFraction(f1);
        BigFraction bf2 =
            new BigFraction(f2);
        return bf1.multiply(bf2);
    });

...  
if (!(f.isDone()  
    || !f.isCancelled()))
    f.cancel();
```

May help to an asynchronous program more efficient wrt resource usage
The Cons of Java Futures
The Cons of Java Futures

- Cons of async calls with Java futures
The Cons of Java Futures

• Cons of async calls with Java futures
  • Limited feature set
The Cons of Java Futures

- Cons of async calls with Java futures
- Limited feature set
  - *Cannot* be completed explicitly
  - e.g., additional mechanisms like FutureTask are needed

See [docs.oracle.com/javase/8/docs/api/java/util/concurrent/FutureTask.html](docs.oracle.com/javase/8/docs/api/java/util/concurrent/FutureTask.html)
The Cons of Java Futures

- Cons of async calls with Java futures
  - Limited feature set
    - *Cannot* be completed explicitly
    - *Cannot* be chained fluently
      - i.e., trigger dependent actions to handle results of async processing

See [en.wikipedia.org/wiki/Fluent_interface](en.wikipedia.org/wiki/Fluent_interface)
The Cons of Java Futures

- Cons of async calls with Java futures
- Limited feature set
  - *Cannot* be completed explicitly
  - *Cannot* be chained fluently
  - *Cannot* be triggered reactively
    - i.e., must (timed-)wait or poll

```java
String f1 = "62675744/15668936";
String f2 = "609136/913704";

Future<BigFraction> f =
    commonPool().submit(() -> {
        BigFraction bf1 =
            new BigFraction(f1);
        BigFraction bf2 =
            new BigFraction(f2);
        return bf1.multiply(bf2);
    });
...

BigFraction result = f.get();
// f.get(10, MILLISECONDS);
// f.get(0, 0);
```
The Cons of Java Futures

- Cons of async calls with Java futures
- Limited feature set
  - *Cannot* be completed explicitly
  - *Cannot* be chained fluently
  - *Cannot* be triggered reactively
    - i.e., must (timed-)wait or poll

"open mouth, insert foot"

Nearly always the wrong thing to do!!
The Cons of Java Futures

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- Limited feature set
  - *Cannot* be completed explicitly
  - *Cannot* be chained fluently
  - *Cannot* be triggered reactively
  - *Cannot* be treated efficiently as a collection of futures

```java
Future<BigFraction> future1 = commonPool().submit(() -> {
    ... });

Future<BigFraction> future2 = commonPool().submit(() -> {
    ... });

... future1.get();
future2.get();
```

*Can’t wait efficiently for the completion of whichever async computation finishes first*
The Cons of Java Futures

• Cons of async calls with Java futures
  • Limited feature set
    • *Cannot* be completed explicitly
    • *Cannot* be chained fluently
    • *Cannot* be triggered reactively
    • *Cannot* be treated efficiently as a *collection* of futures

In general, it’s awkward & inefficient to “compose” multiple futures
The Cons of Java Futures

- These limitations with Java futures motivate the need for the Java completable futures framework!

See lesson on “Overcoming Limitations with Java Futures via Java Completable Futures”
End of Evaluating the Pros & Cons of Java Futures