

Evaluating the Pros & Cons of Java Futures

Douglas C. Schmidt

d.schmidt@vanderbilt.edu

www.dre.vanderbilt.edu/~schmidt

Professor of Computer Science

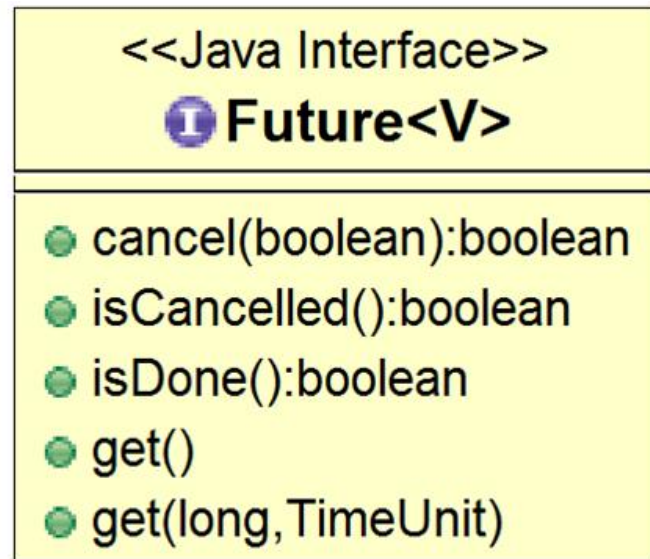
**Institute for Software
Integrated Systems**

**Vanderbilt University
Nashville, Tennessee, USA**



Learning Objectives in this Part of the Lesson

- 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 BigInteger objects concurrently via Java futures
- Motivate the need for Java completable futures by evaluating the pros & cons with Java futures



LIMITED

The Pros of Java Futures

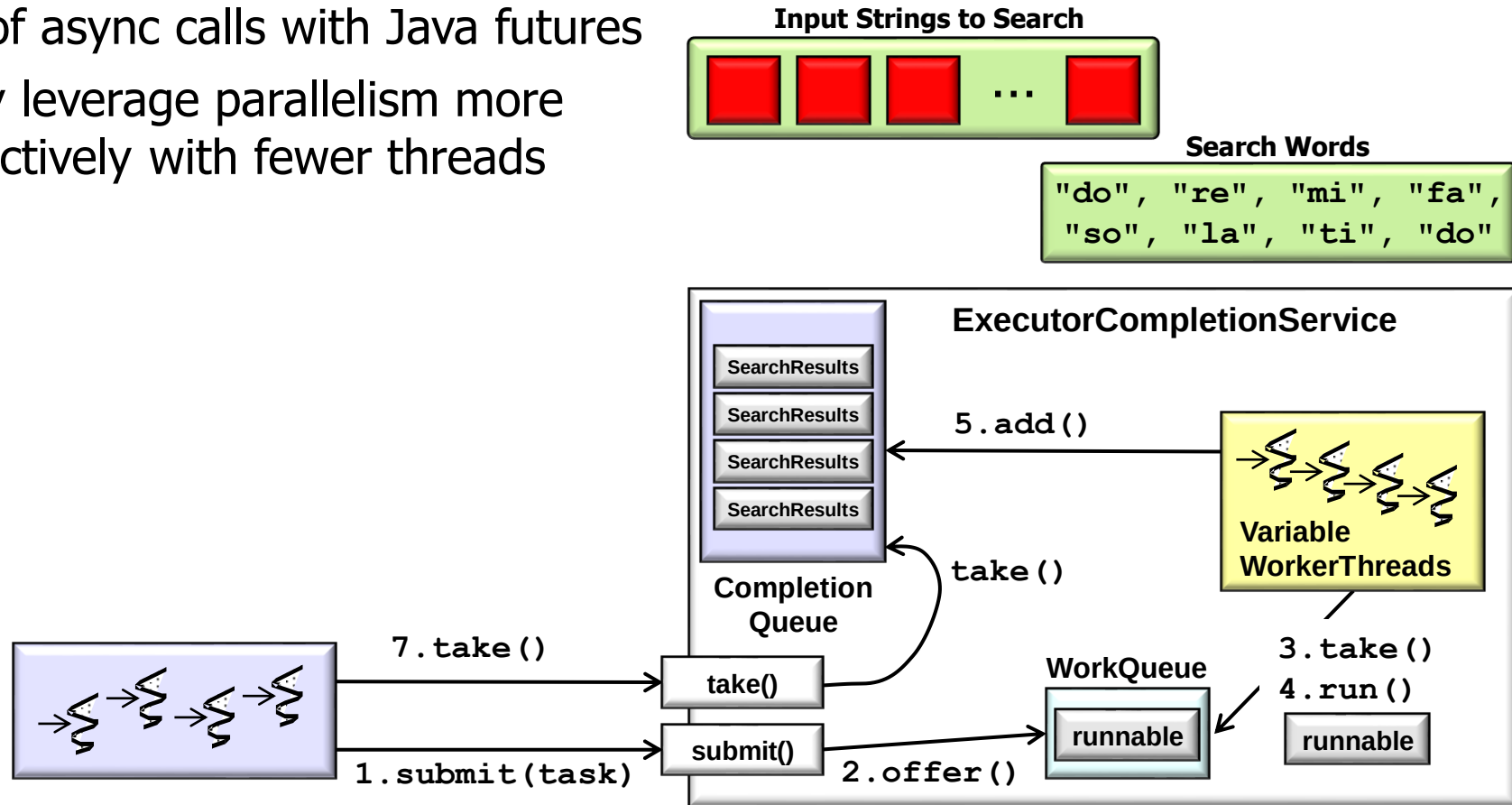
The Pros of Java Futures

- 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

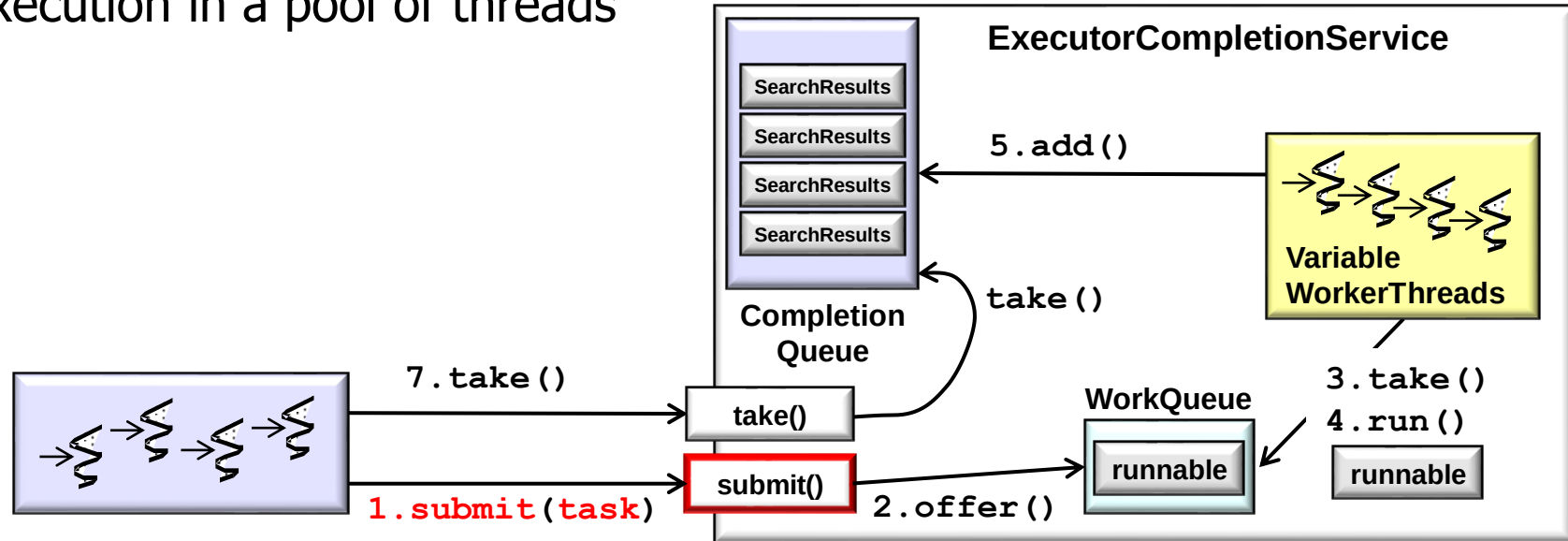


The Pros of Java Futures

- 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

`mCompletionService`

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



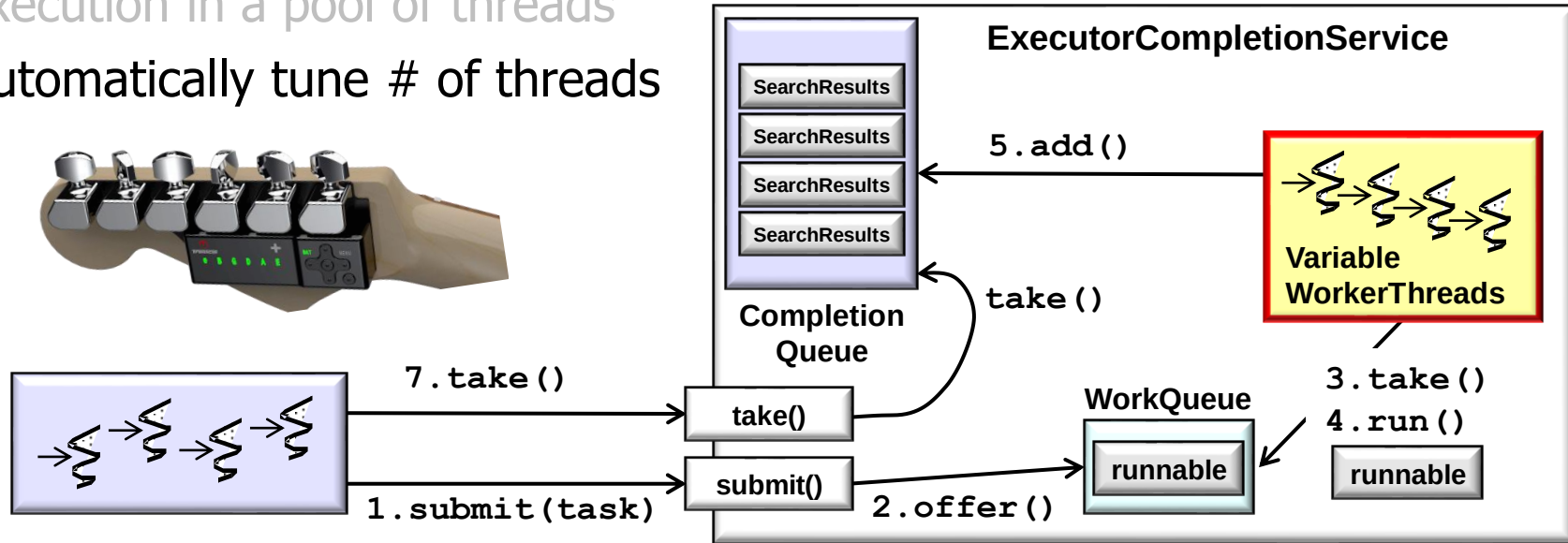
The Pros of Java Futures

- 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

`mCompletenesservice`

`.submit() ->`

`searchForWord(word,
input));`



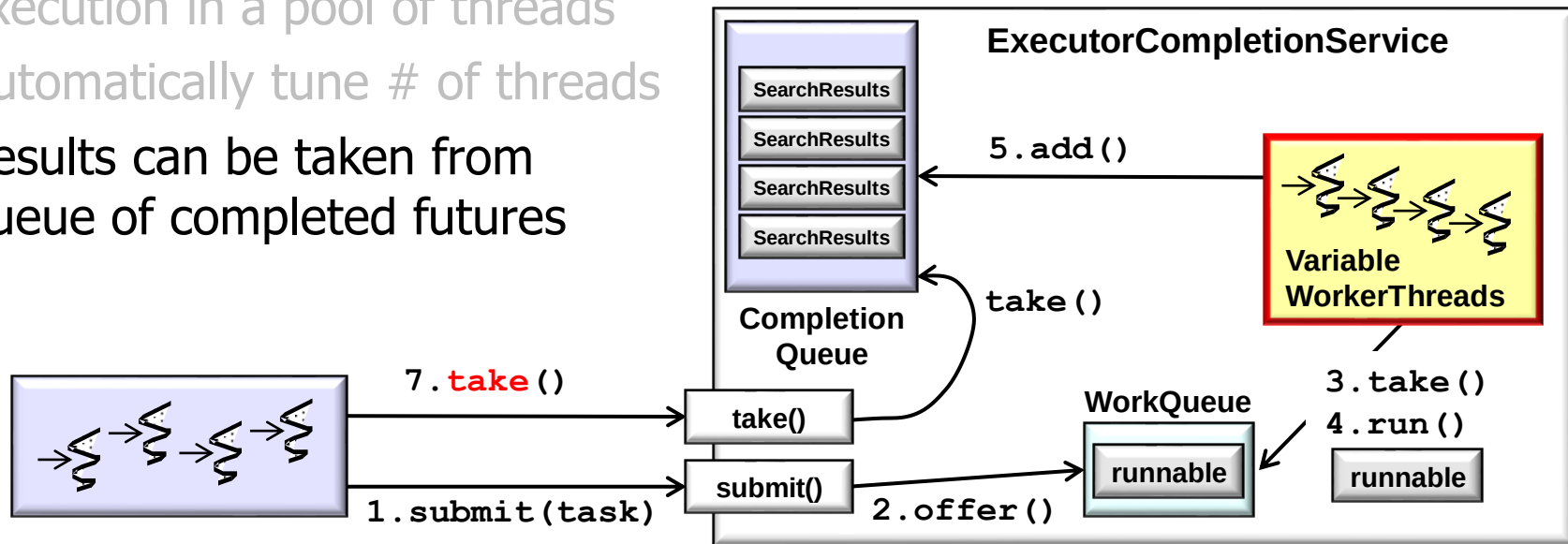
The Pros of Java Futures

- 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();
```

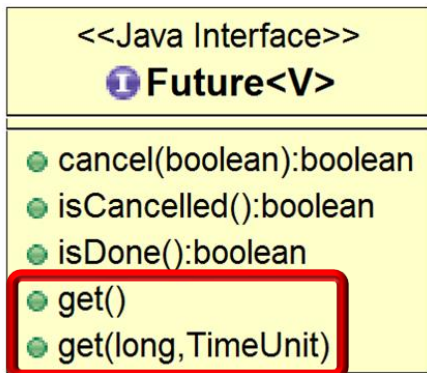
take() blocks, but get() doesn't

```
resultF.get().print()
```



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



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

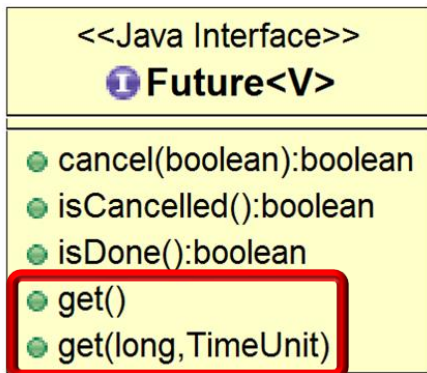
```
Future<BigFraction> f =  
    commonPool().submit(() -> {  
        BigFraction bf1 =  
            new BigFraction(f1);  
        BigFraction bf2 =  
            new BigFraction(f2);  
        return bf1.multiply(bf2);  
    });
```

...

```
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



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

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

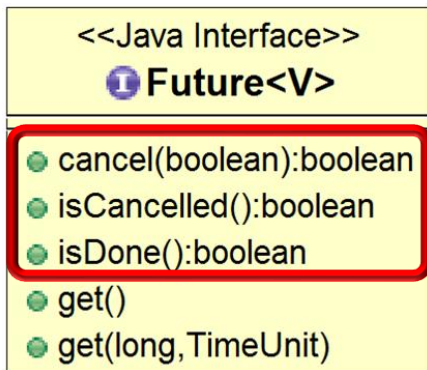
...

```
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

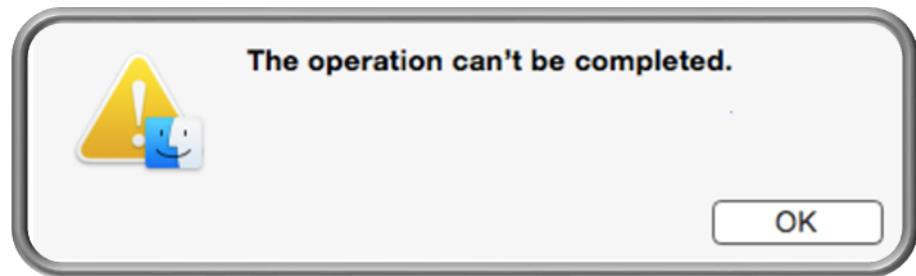
- Cons of async calls with Java futures
 - Limited feature set

<<Java Interface>> I Future<V>
• cancel(boolean):boolean • isCancelled():boolean • isDone():boolean • get() • get(long, TimeUnit)

LIMITED

The Cons of Java Futures

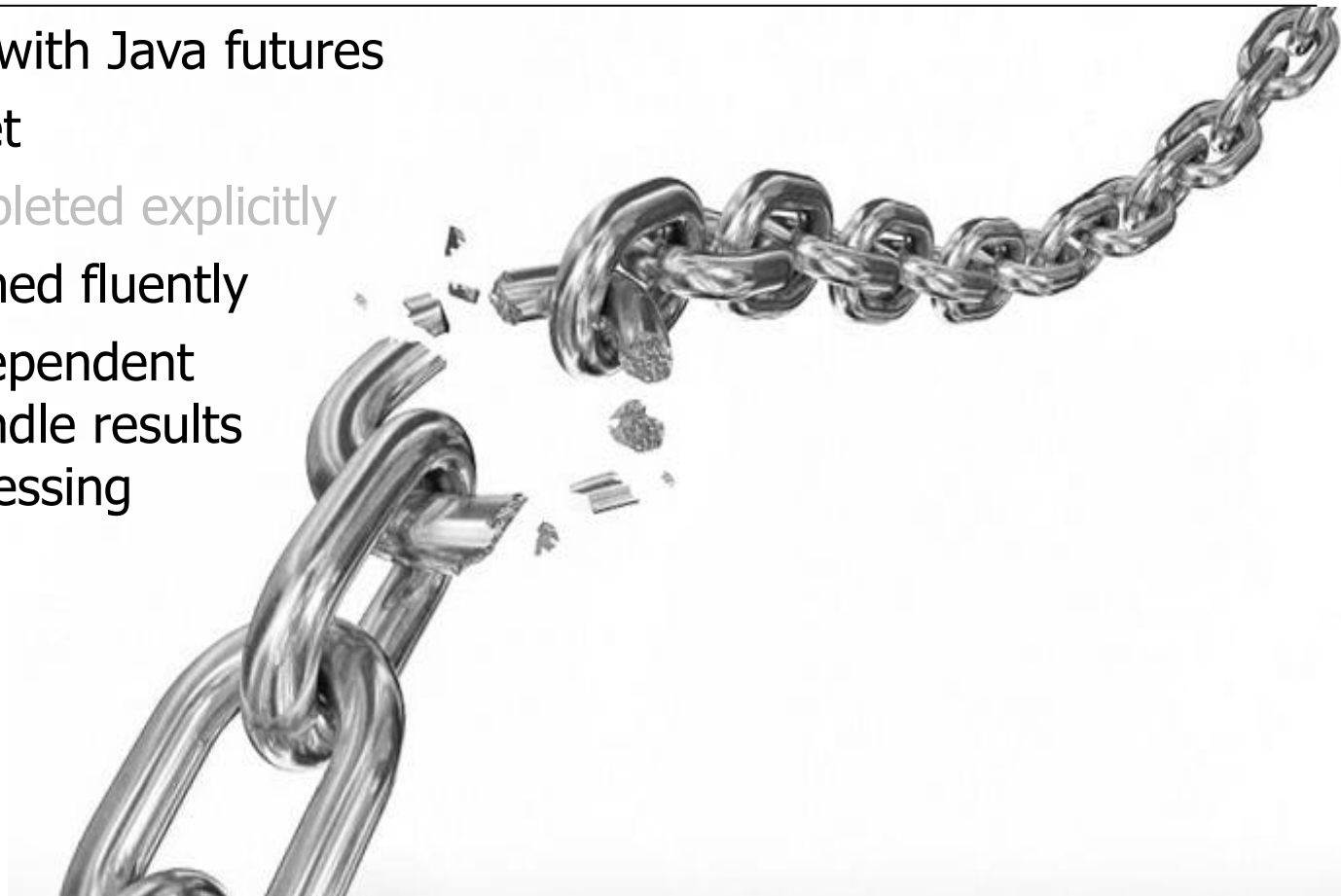
- Cons of async calls with Java futures
 - Limited feature set
 - *Cannot* be completed explicitly
 - e.g., additional mechanisms like FutureTask are needed



See docs.oracle.com/javase/8/docs/api/java/util/concurrent/FutureTask.html

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

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



```
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!!*

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

```
Future<BigFraction> f =  
    commonPool().submit(() -> {  
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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
- Cannot* be treated efficiently as a *collection* of futures

```
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!



Class `CompletableFuture<T>`

```
java.lang.Object  
    java.util.concurrent.CompletableFuture<T>
```

All Implemented Interfaces:

```
CompletionStage<T>, Future<T>
```

```
public class CompletableFuture<T>  
    extends Object  
    implements Future<T>, CompletionStage<T>
```

A `Future` that may be explicitly completed (setting its value and status), and may be used as a `CompletionStage`, supporting dependent functions and actions that trigger upon its completion.

When two or more threads attempt to `complete`, `completeExceptionally`, or `cancel` a `CompletableFuture`, only one of them succeeds.

See lesson on “*Overcoming Limitations with Java Futures via Java Completable Futures*”

End of Evaluating the Pros & Cons of Java Futures