Understanding the Pros & Cons of Synchrony

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Learning Objectives in this Part of the Lesson

- Motivate the need for Java Future & CompletableFuture mechanisms by understanding the pros & cons of synchrony

Overview of Synchrony & Synchronous Operations

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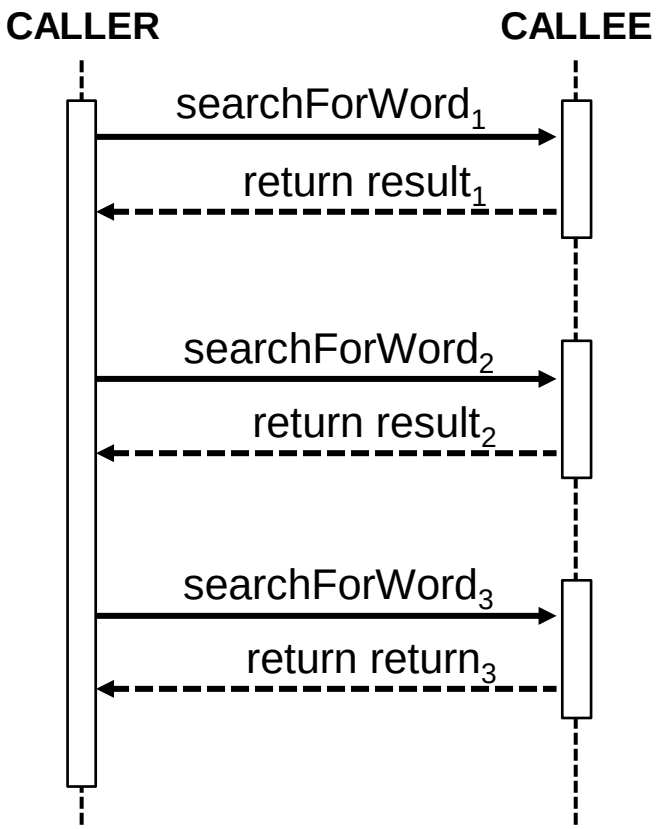
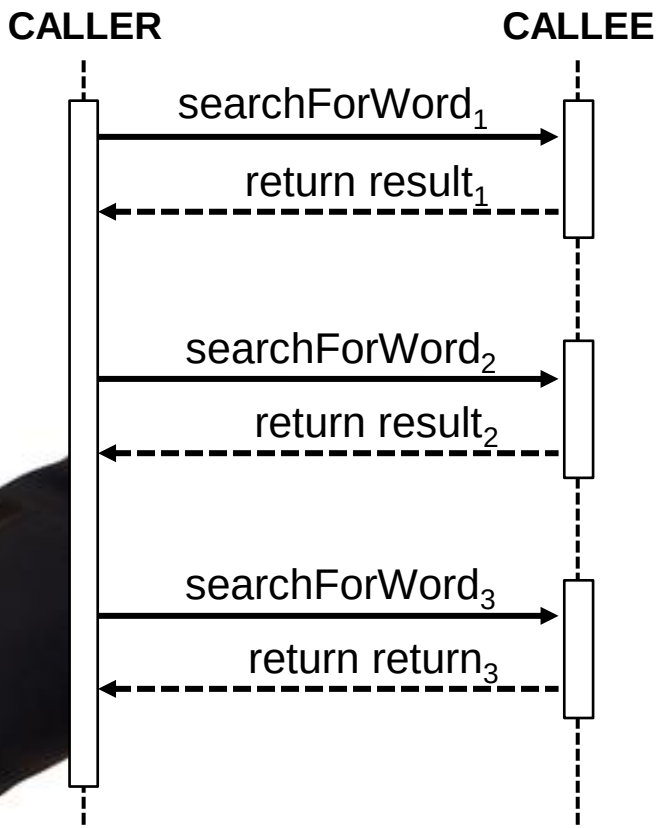
- Method calls in typical Java programs are largely *synchronous*



e.g., calls on Java collections & behaviors in Java stream aggregate operations

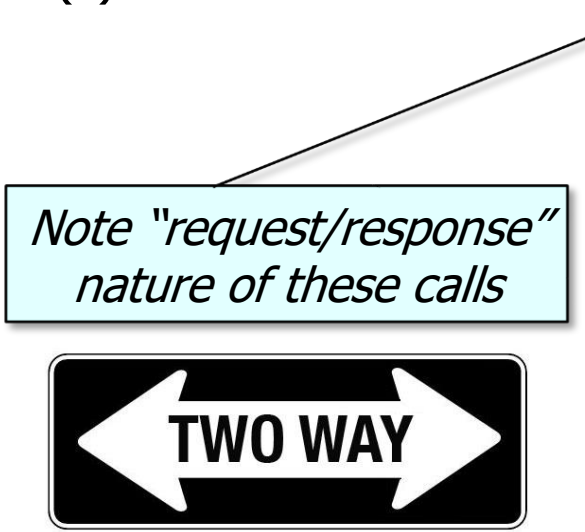
Overview of Synchrony & Synchronous Operations

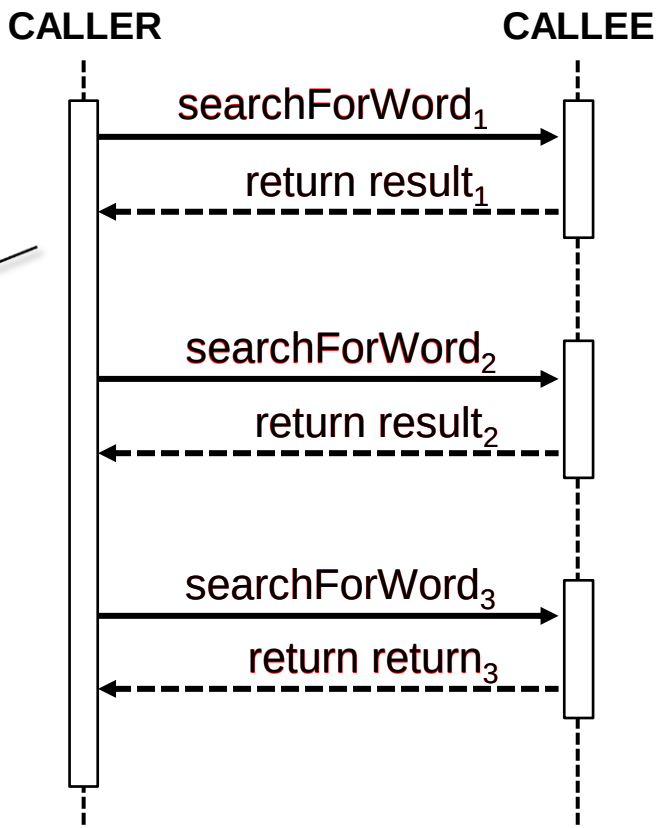
- Method calls in typical Java programs are largely *synchronous*
  - i.e., a callee borrows the thread of its caller until its computation(s) finish



Overview of Synchrony & Synchronous Operations

- Method calls in typical Java programs are largely *synchronous*
  - i.e., a callee borrows the thread of its caller until its computation(s) finish & a result is returned





The Pros of Synchrony

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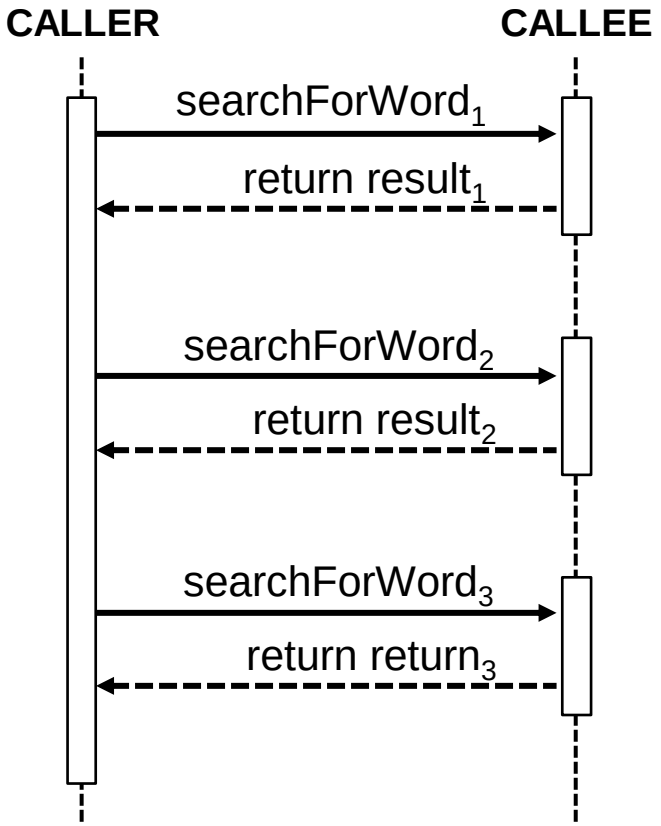
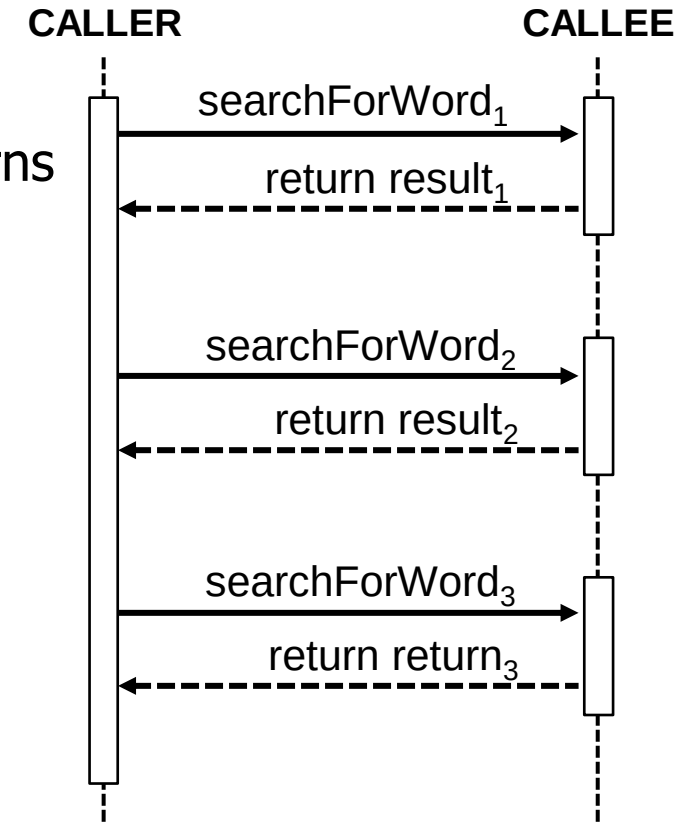
  - "Intuitive" to program & debug



The Pros of Synchrony

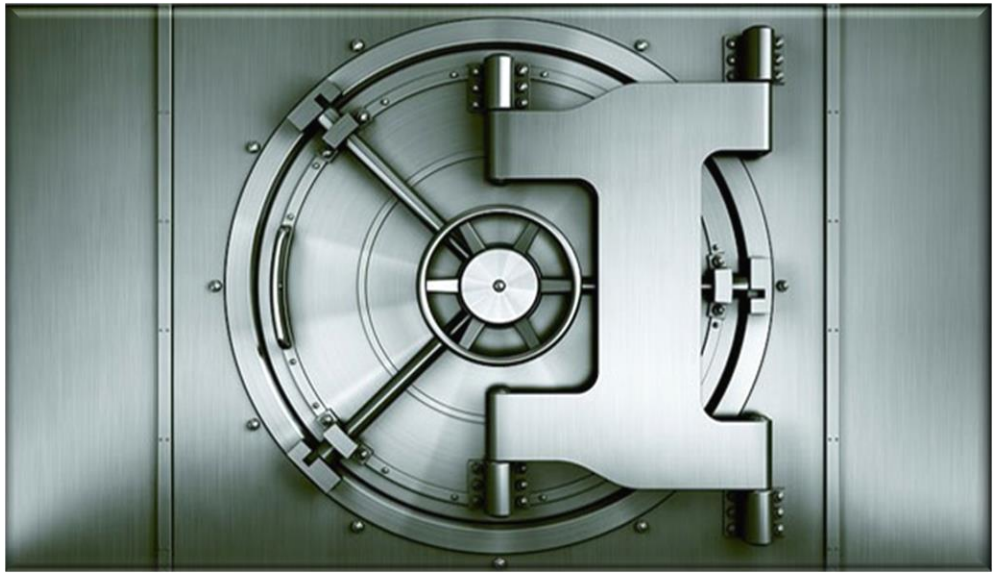
- Pros of synchronous calls
  - "Intuitive" to program & debug, e.g.
    - Maps onto common two-way method patterns

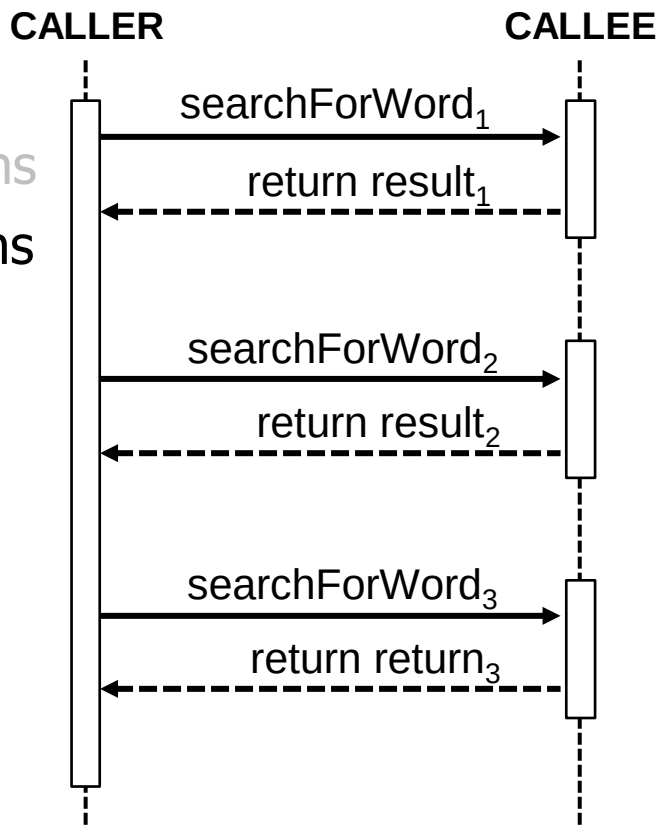


See www.iro.umontreal.ca/~keller/Layla/remote.pdf

The Pros of Synchrony

- Pros of synchronous calls
  - "Intuitive" to program & debug, e.g.
    - Maps onto common two-way method patterns
    - Local caller state retained when callee returns





See wiki.c2.com/?ActivationRecord

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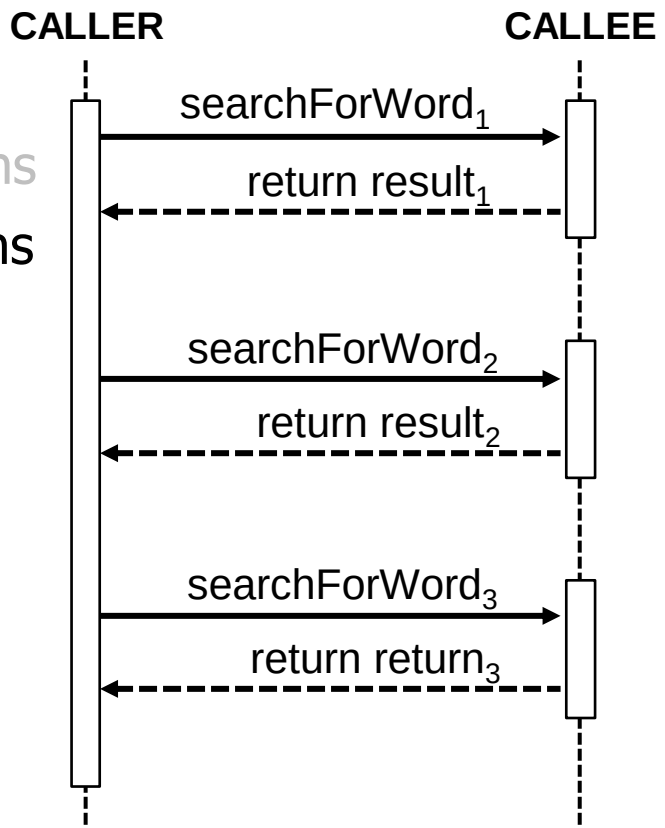
```
byte[] downloadContent(URL url) {
  byte[] buf = new byte[BUFSIZ];
  ByteArrayOutputStream os =
    new ByteArrayOutputStream();
  InputStream is = url.openStream();

  for (int bytes;
       (bytes = is.read(buf)) > 0;)
    os.write(buf, 0, bytes); ...
```



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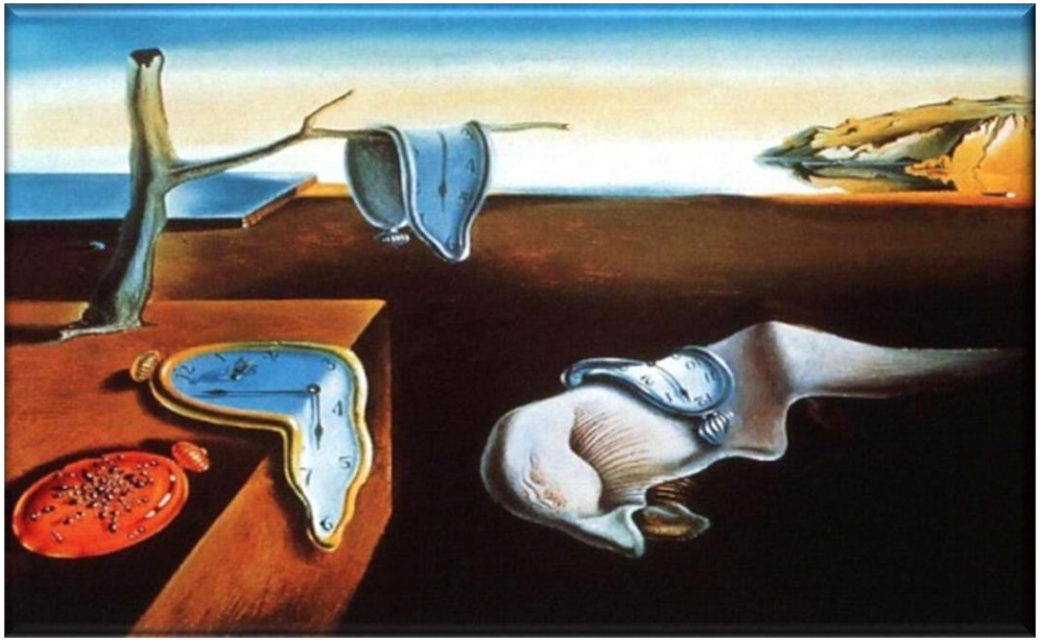
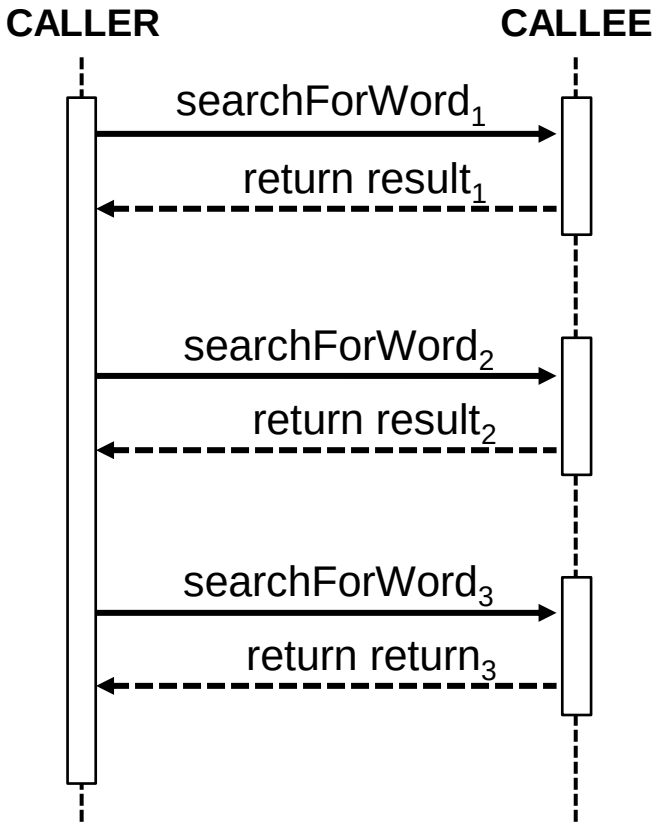
  - May not leverage all parallelism available in multi-core systems

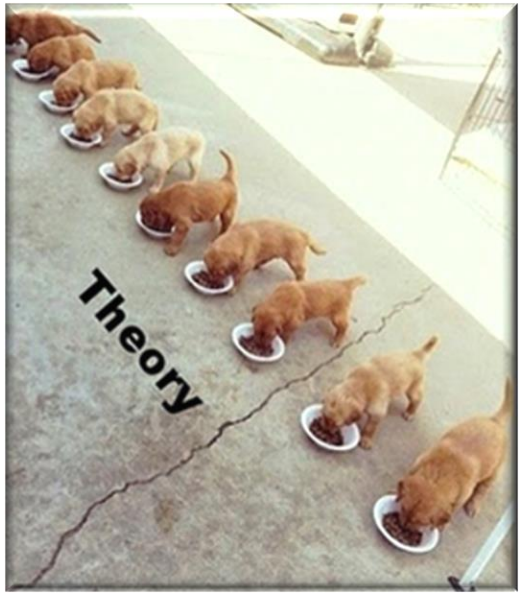




See www.ibm.com/developerworks/library/j-jvmc3

The Cons of Synchrony

- Cons of synchronous calls
  - May not leverage all parallelism available in multi-core systems
    - Blocking threads incur overhead
      - e.g., synchronization, context switching, data movement, & memory management costs



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The Cons of Synchrony

- Cons of synchronous calls
  - May not leverage all parallelism available in multi-core systems
    - Blocking threads incur overhead
  - Selecting right # of threads is hard

Efficient Performance

Efficient Resource Utilization

```
List<Image> filteredImages = urls
   .parallelStream()
   .filter(not(this::urlCached))
   .map(this::downloadImage)
   .map(this::applyFilters)
   .reduce(Stream::concat)
   .orElse(Stream.empty())
   .collect(toList());
```

```
Image downloadImage(URL url){
  return new Image
                (url,
                 downloadContent
                   (url));
}
```

See github.com/douglascraigschmidt/LiveLessons/tree/master/ImageStreamGang

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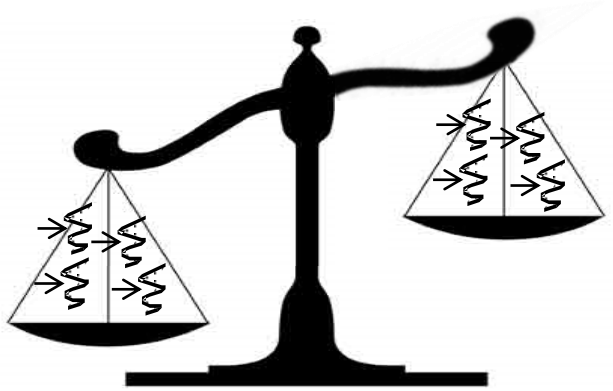

Efficient Performance

Efficient Resource Utilization

A large # of threads may help to improve performance, but can also waste resources

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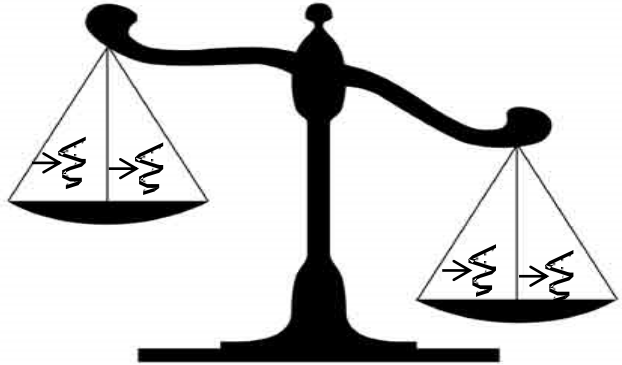

Efficient Performance

Efficient Resource Utilization

A small # of threads may conserve resources at the cost of performance

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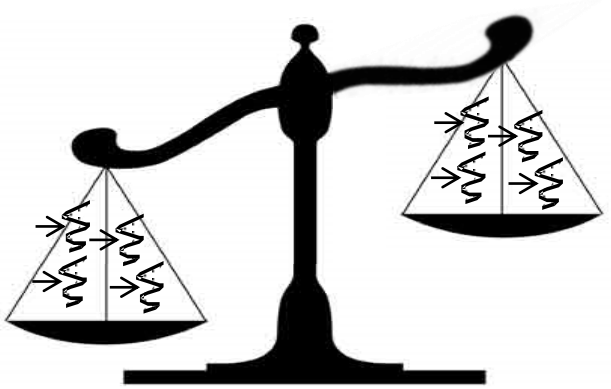

Efficient Performance

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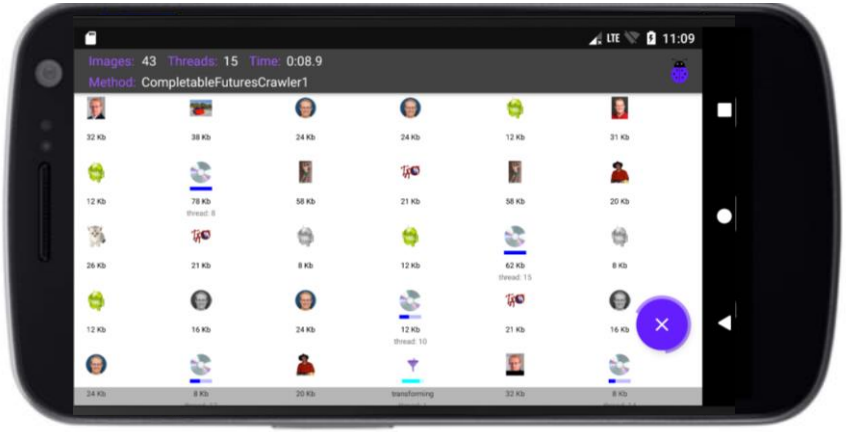


Particularly tricky for I/O-bound programs that need more threads to run efficiently

The Cons of Synchrony

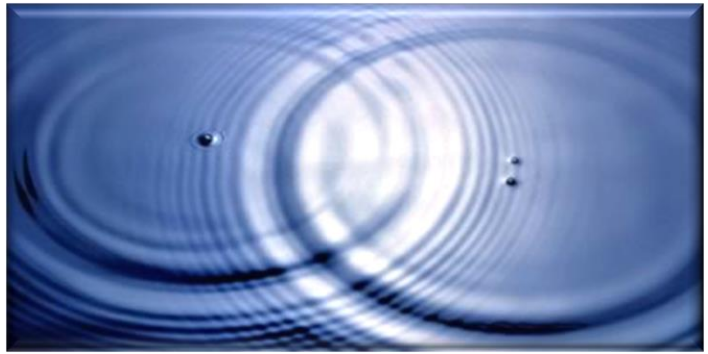
- Cons of synchronous calls
  - May not leverage all parallelism available in multi-core systems
  - May need to change the size of the common fork-join pool

See lesson on "*The Java Fork-Join Pool: Maximizing Core Utilization w/the Common Fork-Join Pool*"

The Cons of Synchrony

- Cons of synchronous calls
  - May not leverage all parallelism available in multi-core systems
  - May need to change the size of the common fork-join pool, e.g.
    - Set a system property

```
String desiredThreads = "10";
System.setProperty
  ("java.util.concurrent." +
   "ForkJoinPool.common." +
   "parallelism",
   desiredThreads);
```



It's hard to estimate the total # of threads to set in the common fork-join pool

The Cons of Synchrony

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  - May need to change the size of the common fork-join pool, e.g.
    - Set a system property
    - Or use the ManagedBlocker to increase common pool size automatically/temporarily

ManageBlockers can only be used with the common fork-join pool..

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

End of Understanding the Pros & Cons of Synchrony