Understand the Pros & Cons of Asynchrony

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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

• Motivate the need for Java futures by understanding the pros & cons of asynchrony
Overview of Asynchrony & Asynchronous Operations
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- Asynchrony is a means of concurrent programming where caller does not block waiting for callee to complete

See en.wikipedia.org/wiki/Asynchrony_(computer_programming)
Overview of Asynchrony & Asynchronous Operations

- Asynchrony is a means of concurrent programming where caller does not block waiting for callee to complete.
- An async call immediately returns a future & while the computation runs “in the background” concurrently.

See en.wikipedia.org/wiki/Asynchronous_method_invocation
Overview of Asynchrony & Asynchronous Operations

- Asynchrony is a means of concurrent programming where caller does not block waiting for callee to complete.
- An async call immediately returns a future & while the computation runs “in the background” concurrently.
- i.e., independent of the calling thread’s flow of control.

See en.wikipedia.org/wiki/Control_flow
Overview of Asynchrony & Asynchronous Operations

- Asynchrony is a means of concurrent programming where caller does not block waiting for callee to complete.
- An async call immediately returns a future & while the computation runs “in the background” concurrently.
- The future is triggered when the computation completes.

See upcoming lessons on “Overview of Java Futures”
Overview of Asynchrony & Asynchronous Operations

- Asynchrony is a means of concurrent programming where caller does not block waiting for callee to complete
  - An async call immediately returns a future & while the computation runs “in the background” concurrently
- The future is triggered when the computation completes
  - The client may or may not block awaiting the results, depending on various factors
Overview of Asynchrony & Asynchronous Operations

• e.g., Android’s AsyncTask framework performs background operations & publishes results on the user-interface (UI) thread without having to manipulate threads and/or handlers.

See developer.android.com/reference/android/os/AsyncTask
Overview of Asynchrony & Asynchronous Operations

• e.g., Android’s AsyncTask framework performs background operations & publishes results on the user-interface (UI) thread without having to manipulate threads and/or handlers

• AsyncTask executes long-duration operations asynchronously in one or more background threads

Background thread(s)

AsyncTask

1. execute(url)

2. onPreExecute()

3. execute(future)

4. doInBackground()

5. onProgressUpdate()

6. onPostExecute()
Overview of Asynchrony & Asynchronous Operations

- e.g., Android’s AsyncTask framework performs background operations & publishes results on the user-interface (UI) thread without having to manipulate threads and/or handlers
  - AsyncTask executes long-duration operations asynchronously in one or more background threads
  - Blocking operations in background threads don’t block the calling (e.g., UI) thread

See developer.android.com/training/multiple-threads/communicate-ui
Overview of Asynchrony & Asynchronous Operations

- e.g., Android’s AsyncTask framework performs background operations & publishes results on the user-interface (UI) thread without having to manipulate threads and/or handlers
  - AsyncTask executes long-duration operations asynchronously in one or more background threads
  - Blocking operations in background threads don’t block the calling (e.g., UI) thread
  - The calling (UI) thread can be notified upon completion, failure, or progress of the async task

AsyncTask shields client code from details of programming futures
The Pros of Asynchrony
The Pros of Asynchrony

- Pros of asynchronous operations
The Pros of Asynchrony

- Pros of asynchronous operations
  - Responsiveness
    - A calling thread needn’t block waiting for the async request to complete

See [en.wikipedia.org/wiki/Asynchronous_method_invocation](en.wikipedia.org/wiki/Asynchronous_method_invocation)
The Pros of Asynchrony

- Pros of asynchronous operations
  - Responsiveness
  - Elasticity
    - Multiple requests can run scalably & concurrently on multiple cores

The Pros of Asynchrony

• Pros of asynchronous operations
  • Responsiveness

• Elasticity
  • Multiple requests can run scalably & concurrently on multiple cores
  • Able to better leverage parallelism available in multi-core systems

See headcrashing.wordpress.com/2015/07/20/iobound-completablefuture
The Pros of Asynchrony

• Pros of asynchronous operations
  • Responsiveness
  • Elasticity
    • Multiple requests can run scalably & concurrently on multiple cores
      • Able to better leverage parallelism available in multi-core systems
    • Elasticity is particularly useful to auto-scale computations in cloud environments

See en.wikipedia.org/wiki/Elasticity_(cloud_computing) & en.wikipedia.org/wiki/Autoscaling
The Cons of Asynchrony
The Cons of Asynchrony

- Cons of asynchronous operations
The Cons of Asynchrony

- Cons of asynchronous operations
- Unpredictability
  - Response times may not unpredictable due to non-determinism of async operations

Non-determinism is a general problem with concurrency & not just asynchrony
The Cons of Asynchrony

- Cons of asynchronous operations
  - Unpredictability
    - Response times may not unpredictable due to non-determinism of async operations
    - Results can occur in a different order than the original calls were made

Additional time & effort may be required if results must be ordered somehow
The Cons of Asynchrony

- Cons of asynchronous operations
  - Unpredictability
- Complicated programming & debugging
The Cons of Asynchrony

- Cons of asynchronous operations
- Unpredictability
- Complicated programming & debugging
- The patterns & best-practices of asynchronous programming are not well understood

See dzone.com/articles/parallel-and-asynchronous-programming-in-java-8
The Cons of Asynchrony

- Cons of asynchronous operations
- Unpredictability
- Complicated programming & debugging
  - The patterns & best-practices of asynchronous programming are not well understood
- Async programming is tricky without proper abstractions

See dzone.com/articles/callback-hell
The Cons of Asynchrony

- Cons of asynchronous operations
  - Unpredictability
  - Complicated programming & debugging
    - The patterns & best-practices of asynchronous programming are not well understood
    - Errors can be hard to track due to unpredictability

The Cons of Asynchrony

- Cons of asynchronous operations
  - Unpredictability
  - Complicated programming & debugging
    - The patterns & best-practices of asynchronous programming are not well understood
    - Errors can be hard to track due to unpredictability

Again, this non-determinism is a general problem with concurrent processing
Weighing the Pros & Cons of Asynchrony
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- Two things are necessary for the pros of asynchrony to outweigh the cons
Weighing the Pros & Cons of Asynchrony

- Two things are necessary for the pros of asynchrony to outweigh the cons
- Performance should improve to offset the increased complexity of programming & debugging

See upcoming lesson on “Java Completable Futures ImageStreamGang Example”
Weighing the Pros & Cons of Asynchrony

- Two things are necessary for the pros of asynchrony to outweigh the cons
  - Performance should improve to offset the increased complexity of programming & debugging
  - An asynchronous programming model should reflect the key principles of the reactive paradigm

See earlier lesson on “Overview of Reactive Programming“
Weighing the Pros & Cons of Asynchrony

Java’s completable futures framework provides an asynchronous concurrent programming model that performs well & supports the reactive paradigm.
End of Understand the Pros & Cons of Asynchrony