23.16 Wrap-Up

In this chapter, we presented Java's concurrency capabilities for enhancing application performance on multi-core systems. You learned the differences between concurrent and parallel execution. We discussed that Java makes concurrency available to you through multithreading. You also learned that the JVM itself creates threads to run a program, and that it also can create threads to perform housekeeping tasks such as garbage collection.

We discussed the life cycle of a thread and the states that a thread may occupy during its lifetime. Next, we presented the interface `Runnable`, which is used to specify a task that can execute concurrently with other tasks. This interface's `run` method is invoked by the thread executing the task. Then we showed how to use the `Executor` interface to manage the execution of `Runnable` objects via thread pools, which can reuse existing threads to eliminate the overhead of creating a new thread for each task and can improve performance by optimizing the number of threads to ensure that the processor stays busy.

You learned that when multiple threads share an object and one or more of them modify that object, indeterminate results may occur unless access to the shared object is managed properly. We showed you how to solve this problem via thread synchronization, which coordinates access to shared mutable

data by multiple concurrent threads. You learned several techniques for performing synchronization—first with the built-in class `ArrayBlockingQueue` (which handles *all* the synchronization details for you), then with Java's built-in monitors and the `synchronized` keyword, and finally with interfaces `Lock` and `Condition`.

We discussed the fact that JavaFX GUIs are not thread safe, so all interactions with and modifications to the GUI must be performed in the JavaFX application thread. We also discussed the problems associated with performing long-running calculations in that thread. Then we showed how you can use class `Task` to perform long-running calculations in worker threads. You learned how to use a `Task`'s properties to display the results of a `Task` in a GUI when the calculation completed and how to display intermediate results while the calculation was still in process.

We revisited the `Arrays` class's `sort` and `parallelSort` methods to demonstrate the benefit of using a parallel sorting algorithm on a multi-core processor. We used the Java SE 8 Date/Time API's `Instant` and `Duration` classes to time the sort operations.

You learned that Java SE 8 streams are easy to parallelize, enabling programs to benefit from enhanced performance on multi-core systems, and that to obtain a parallel stream, you simply invoke method `parallel` on an existing stream.

We discussed the `Callable` and `Future` interfaces, which enable you to execute tasks that return results and to obtain

those results, respectively. We then presented an example of performing long-running tasks synchronously and asynchronously using Java SE 8's `CompletableFuture` class. In the next chapter, we introduce database-application development with Java's JDBC API.