

Exercises week 7

Friday 9 October 2015*

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Goal of the exercises

The goal of this week's exercises is for you to show that you can write responsive user interfaces using threads and make them work correctly.

Due to the fall break, the handin deadline for these exercises is Thursday 22 October 2015. Also, due to the Algorithm Design exam on 21 October, which presumably occupy many of you, the workload is modest.

Do this first

Get and unpack this week's example code in zip file `pcpp-week07.zip` on the course homepage.

Exercise 7.1 File `TestFetchWebGui.java` contains a simple Java Swing user interface to initiate the fetching of some web pages and then report their sizes.

As implemented, the program uses a single `SwingWorker` subclass instance to fetch all the web pages sequentially, which is slow because each download has to complete before the next one starts. In this exercise you must change it so that it initiates multiple downloads at the same time, and prints the results as they become available.

1. Implement concurrent download. You can ignore the cancellation button and progress bar for now. There seems to be two ways to implement concurrent download of N webpages. Either (1) create N `SwingWorker` subclass instances that each downloads a single webpage; or (2) create a single `SwingWorker` subclass instance that itself uses Java's executor framework to download the N web pages concurrently. Approach (1) seems more elegant because it uses the `SwingWorker` executor framework only, instead of using two executor frameworks. Also, approach (2) seems dubious unless it is clear that a `SwingWorker`'s `publish` method can be safely called on multiple threads; what does the Java class library documentation say about this? Implement and explain the correctness of your solution for concurrent download.
2. Make the cancellation button work also with concurrent download.
3. Make the progress bar work also with concurrent download. One way to do this is to create an `AtomicInteger` that all the download operations update as they complete, and let them all call `setProgress` with a suitable value.

Exercise 7.2 File `TestLiftGui.java` contains an implementation of a lift simulator, corresponding to the north end of the IT University's atrium: two lifts, both serving seven floors, from basement (floor number -1) to floor 5.

1. Explain why the whole simulation and its graphical user interface is thread-safe, in spite of the Swing GUI toolkit components not being thread-safe.
2. (There is no subquestion 2).
3. Change the lift simulator and GUI to work for a hotel with four lifts, all of which serve floors -2 through 10, and still with a single lift controller.
4. In the current implementation, each lift has a thread whose `run` method uses the `Thread.sleep` method to sleep most of the time. An alternative design is to use the Java executor framework, for instance, a scheduled thread pool, to periodically update each lift's state. The `scheduleAtFixedRate` method of the `ScheduledThreadPoolExecutor` class in package `java.util.concurrent` seems relevant. In this design, each lift is represented by a `Runnable` whose `run` method gets called, say, 16 times a second. The main work in this rewriting probably is to introduce extra fields in the `Lift` object so that the lift "knows" which state it is in: going nowhere (direction `None`), going up (direction `Up`), going down (direction `Down`), opening doors, or closing doors, and so that the `run` method can act accordingly. There should be **no** calls to `sleep` left in the `Lift` methods.
5. Modify the user interface so that a lift's inside buttons show which floors the lift will eventually stop at. For instance, you may set the foreground (text) color of the button for a given floor to `Color.RED` when the lift will stop there, otherwise the (default) `Color.BLACK`.