

Exercise 06

In this exercise, you get to do the same thing you did in the previous exercise, except this time, you're going to use Java. This will give you a first chance to work with multi-threading in Java, and it will let you see that, just like with C, the thread execution is scheduled by the operating system. It will usually vary some from execution to execution, and, to write a multi-threaded program, we have to consider all possible execution orders.

On the course homepage, you'll find a partial implementation of a program called **Interleaving.java**. The main thread of this program runs a loop for 50,000 iterations using `System.out` to print out a newline at the end of each iteration.

Add code to create three new threads on each iteration of this loop, start them all, then join with them all before printing the newline. Each thread will be implemented with a different subclass of `Thread` (or a different subclass of `Runnable`, either is fine). One thread will use `System.out.print()` to print out the letter, 'a', then another call to `System.out.print()` to print the letter, 'b'. The next thread will do the same thing, except it will print 'c', then 'd'. The third will use the same technique to print 'e' then 'f'.

As with the previous exercise, on each iteration of the loop in `main()`, we should get an output line with six characters. The order of these characters will be determined by the execution order of the threads. You might expect an order like “abcdef”, but that's not always what you'll get (especially on a multi-core machine). You might get “efcdab” if the last thread gets to run first, and you might even get a line like “acebdf” if the threads execute concurrently or in parallel.

Let's give it a try. Run your program as follows and see how many different execution orders you get:

```
$ java Interleaving | sort | uniq
```

I got about 20 different execution orders when I ran this program on my 4-core Linux laptop.

When you're done, submit the completed source file, `Interleaving.java`. I've prepared an assignment named `exercise_06` on Moodle.