

# Concurrency Quiz: Java Threads

First name, last name: .....

## Background information

In this part of the quiz, we would like to collect some information concerning your prior experience with concurrent programming.

What level of studies are you currently completing?

- Bachelor in Computer Science
- Master in Computer Science
- PhD in Computer Science

Other: .....

Which semester are you currently completing? (e.g. 4th) .....

## Prior experience with concurrency

Have you ever taken or are you currently taking a course other than Software Architecture that covers concurrent programming?

- Yes
- No
- No, but I studied it on my own (e.g. through online tutorials, books, ...)

If yes, what course was/is it and when did you take it? (Please provide details below.)

- Parallel programming @ ETH Zurich by T. Gross in Spring .....
- Concepts of concurrent computation @ ETH Zurich by B. Meyer in Spring .....
- Other courses:

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How much of the self-study material on concurrency that you worked with today did you already know before?

- none
- 10%
- 20%
- 30%
- 40%
- 50%
- 60%
- 70%
- 80%
- 90%
- all

**Programming experience (sequential and concurrent)**

	(1: a novice ... 5: an expert)
Concerning your <b>general programming experience</b> , do you consider yourself...	1 2 3 4 5 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
Concerning your experience with <b>concurrent programming</b> , do you consider yourself...	1 2 3 4 5 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
Concerning your experience with the programming language <b>Eiffel</b> , do you consider yourself...	1 2 3 4 5 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
Concerning your experience with the programming language <b>Java</b> , do you consider yourself...	1 2 3 4 5 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
Concerning your experience with <b>Java Threads</b> , do you consider yourself...	1 2 3 4 5 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
Concerning your experience with <b>SCOOP</b> , do you consider yourself...	1 2 3 4 5 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>

**Self-study material**

Where did you work through the self-study material?

- In the morning lecture     In the exercise class     At home

	(1: totally disagree ... 5: totally agree)
The self-study material was easy to follow.	1 2 3 4 5 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
The self-study material provided enough <b>examples</b> to help me understand the subject.	1 2 3 4 5 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
The self-study material provided enough <b>exercises</b> to help me understand the subject.	1 2 3 4 5 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
I was able to complete the tutorial within 90 minutes.	1 2 3 4 5 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
The self-study material is a good alternative to the traditional lectures.	1 2 3 4 5 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
I feel confident that I will be able to solve the tasks in this quiz.	1 2 3 4 5 <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>

Any comments on the self-study material: .....

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# 1 Sequential comprehension

Write down the output of the sequential Java program shown below.

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<pre>public class Application {     public static A a;     public static B b;     public static C c;      public Application() {         c = new C(); a = new A(c);         b = new B(c);         System.out.print("A");         execute();         System.out.print("L");     }      public void execute() {         a.m();         b.n();         if (a.done &amp;&amp; b.done)             System.out.print("M");     } }</pre>	<pre>public class A {     C c;     boolean done;      public A(C cc) {         c = cc;         done = false;     }      public void m() {         c.f();         done = true;     } }</pre>	<pre>public class B {     C c;     boolean done;      public B(C cc) {         c = cc;         done = false;     }      public void n() {         c.g();         done = true;         System.out.print("T");     } }</pre>
<pre>public class Root {     public static void main(String         [] args) {         Application app = new             Application();     } }</pre>	<pre>public class C {     boolean done;      public void f() {         System.out.print("F");         done = false;     }      public void g() {         System.out.print("S");         done = true;     } }</pre>	

## 2 General concurrency concepts

What is multiprocessing?

- Execution of multiple processes, within a single computer sharing a single processing unit.
- Execution of a single process on a single computer.
- Execution of a single process within multiple computers.
- Execution of multiple processes within a single computer sharing two or more processing units.

Which of the following state transitions is not possible in the status of a process?

- running  $\rightarrow$  ready
- ready  $\rightarrow$  blocked
- blocked  $\rightarrow$  ready
- running  $\rightarrow$  blocked

In the space below explain the terms data race and mutual exclusion.

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What is a deadlock?

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### 3 Comprehension

Write down three possible (non-deadlock) outputs for the Java Threads program shown below:

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<pre> <b>public class</b> Application <b>extends</b> Thread {     <b>public static</b> A a;     <b>public static</b> B b;     <b>public static</b> C c;     <b>public static</b> D d;      <b>public void</b> run() {         c = <b>new</b> C(); a = <b>new</b> A(c);         b = <b>new</b> B(c); d = <b>new</b> D();         System.out.print("A");         execute();         System.out.print("L");     }      <b>public void</b> execute() {         a.start(); b.start(); d.foo();         <b>try</b> {             a.join(); b.join();         }         <b>catch</b>             (InterruptedException e) { };         <b>if</b> (a.done_a &amp;&amp; b.done_b)             System.out.print("M");     } }                 </pre>	<pre> <b>public class</b> A <b>extends</b> Thread {     C c;     <b>boolean</b> done_a;      <b>public</b> A(C cc) {         c = cc;     }      <b>public void</b> run() {         <b>try</b> {m(); m();}         <b>catch</b> (InterruptedException             e) {};     }      <b>public void</b> m() <b>throws</b>         InterruptedException {         <b>synchronized</b> (c) {             <b>while</b> (!c.done) c.wait();         }         <b>synchronized</b> (c) {             c.f(); c.notifyAll();         }         done_a = <b>true</b>;     } }                 </pre>	<pre> <b>public class</b> B <b>extends</b> Thread {     C c;     <b>boolean</b> done_b;      <b>public</b> B(C cc) {         c = cc;     }      <b>public void</b> run() {         <b>try</b> {n(); n();}         <b>catch</b> (InterruptedException             e) {};     }      <b>public void</b> n() <b>throws</b>         InterruptedException {         <b>synchronized</b> (c) {             <b>while</b> (c.done) c.wait();         }         <b>synchronized</b> (c) {             c.g(); c.notifyAll();         }         done_b = <b>true</b>;         System.out.print("T");     }}                 </pre>
<pre> <b>public class</b> Root {     <b>public static void</b> main(String[]         args) {         Application app = <b>new</b>             Application();         app.start();     } }                 </pre>	<pre> <b>public class</b> C {     <b>boolean</b> done;     <b>public void</b> f() {         System.out.print("F");         done = <b>false</b>;     }     <b>public void</b> g() {         System.out.print("S");         done = <b>true</b>;     } }                 </pre>	<pre> <b>public class</b> D {     <b>public void</b> foo() {         System.out.print("P");     } }                 </pre>

## 4 Errors

Identify errors (possibly compile-time) in the following Java Threads code segment. Justify your answers by providing on the next page the line number and a short explanation for every detected error. (The number of provided spaces does not necessarily correspond to the actual number of errors.)

```

1 class A extends Thread {
2   static B b;
3   static boolean done = false;
4
5   public static void main(String[] args) {
6     A a = new A();
7     b = new B();
8     C c = new C(b);
9
10    try {
11      a.start();
12      b.start();
13      c.start();
14      while (!done) {
15        System.out.println(b.g());
16      }
17      b.notifyAll();
18      a.join();
19      c.start();
20    }
21    catch (InterruptedException e) {}
22  }
23
24  public void run() {
25    int i;
26    for (i = 0; i < 100; i++) {
27      b.f();
28    }
29    done = true;
30  }
31 }

```

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32 class B {
33   int k = 0;
34
35   public synchronized int g() {
36     notify();
37     return k;
38   }
39
40   public void f() {
41     synchronized {
42       wait();
43       k++;
44     }
45   }
46 }

```

```

47 class C extends Thread {
48   private B b;
49
50   public C(B bb) {
51     b = bb;
52   }
53
54   public void h() {
55     synchronized (b) {
56       b.k--;
57       notify();
58     }
59   }
60
61   public void run() {
62     int i;
63     for (i = 0; i < 100; i++) {
64       h();
65     }
66   }
67 }

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**Line number**   **Explanation**

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## 5 Program Construction

Consider a class *Data* with two integer fields *x* and *y*, both of which are initialized to 0. Two classes *C0* and *C1* share an object *data* of type *Data*. Class *C0* implements the following behavior, which is repeated continuously: if both values *data.x* and *data.y* are set to 1, it sets both values to 0; otherwise it waits until both values are 1. Conversely, class *C1* implements the following behavior, which is also repeated continuously: if both values *data.x* and *data.y* are set to 0, it sets both values to 1; otherwise it waits until both values are 0. The following condition must always hold when *data* is accessed:

$$(data.x = 0 \wedge data.y = 0) \vee (data.x = 1 \wedge data.y = 1)$$

Write a concurrent program using Java Threads that implements the described functionality. Besides the mentioned classes *Data*, *C0*, and *C1*, your program needs to have a root class which ensures that the behaviors of *C0* and *C1* are executed in different threads.

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## Feedback on the quiz

How much time did you spend on this quiz?

20' 30' 40' 50' 60' 70' 80' 90' 100' 110' 120'

The difficulty level of the quiz was... (1: too easy, 2: easy, 3: just right, 4: difficult, 5: too difficult)	1	2	3	4	5
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I feel confident that I solved the tasks of this quiz correctly. (1: totally disagree ... 5: totally agree)	1	2	3	4	5
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Did you leave any questions of the quiz empty and if so, why? .....

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Any comments on the quiz: .....

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