Mathematics and Computer Science
Technical University of Denmark
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HHL 2024–09–23

02158 CONCURRENT PROGRAMMING FALL 2024

Exercise Class 2

Thursday September 26

Atomic Actions

1. Let P_1 and P_2 be two processes each performing the statement $x := x+1$ five times. Given that the initial value of x is 0, what are the possible terminal values of x? **Check your results with the teaching assistant!**

2. If an action a followed by an action b has the same effect on the state as b followed by a, does this mean that they are atomic? And vice versa?

3. A process P uses three shared integer variables x, y, and z. The variable x is both read and written by other processes, whereas the variables y and z are read, but not written, by other processes. Determine which of the following statements in P can be considered to be atomic.

a:	$x := x + 1$	d:	$z := x + y$
b:	$x := y + 1$	e:	**await** $x + y + z > 0$
c:	$y := z + 1$	f:	$(x, y) := (1, 2)$

4. Why should the variables in the *Rule of Critical References* (or the *At-Most-Once Property*) be *simple*, ie. be containable in a machine word?

5. Boolean variables are definitely simple. But what can happen if boolean variables are implemented as individual bits of a machine word? [Consider how to set a particular bit and then setting two bits concurrently.]

Critical regions

6. Do Exercise Share.2 (in [Aux]).

7. What is the difference between a *critical section* and a *critical region*? [According to HHL]

8. Can other processes be active when a process is inside a critical region?

9. Is it possible to have more than one critical region in a concurrent program?

Temporal Logic

10. Let $Snows(x)$ denote that it snows at destination x. Express the following using temporal logic:

(a) It never snows at Bermuda.
(b) If it snows in Helsinki it also snows in Finland.
(c) If it snows in Norway, it will eventually snow in Sweden.
(d) It will always snow again in New Zealand and Danmark, but never at the same time.
(e) If it should ever snow in Sahara, it will never stop.
(f) It always snows somewhere.