Informatics and Mathematical Modelling *HHL 2008–09–12*
Technical University of Denmark
Building 321
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02152 CONCURRENT SYSTEMS FALL 2008

CP Exercise Class 2

Monday September 15

Transition Systems and Atomic Actions

1. A process P uses two shared integer variables x and y as well as a local variable t. The variable x is both read and written by other processes, whereas y is only read by other processes. Determine which of the following statements in P can be considered to be atomic.

$$\begin{array}{llll} a: & x := x+1 & d: & x := y+1 \\ b: & y := y+1 & e: & t := y+y \\ c: & y := x+1 & f: & t := x+x \end{array}$$

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. 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!**

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?

Critical regions

6. Do Exercise Share.2.

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?

10. Do Andrews Ex. 3.3 (a).

11. Is there such an atomic swap-operation on your computer?

12. Now you should try to *prove* that your solution is correct. That is, you should establish an invariant that expresses a relationship between the variables of your program. Combined with local invariants, your should be able to infer that mutual exclusion holds.

13. Now, do part (b) of Andrews Ex. 3.3 (cf. section 3.2.2). Is your proof still valid?