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Hand in until November 21st, 2018
15:59 via the post boxes
Discussion: November 26/27th, 2018

Tutorial for Cyber-Physical Systems - Discrete Models
Exercise Sheet 5

The goal of this exercise sheet is to get an understanding of the mutual exclusion property.The goal of this exercise sheet is to get an understanding of the intricacies of synchronization and communication in a cyber-physical system, at the example of a simplified version of a system (only two components which each execute a program to ensure mutual exclusion in the access of a critical resource (i.e., a mutual-exclusion protocol).

Exercise 1: Peterson's Mutual Exclusion Algorithm

In the lecture, you have seen a version of Peterson's mutual exclusion algorithm in which each of the two processes did the assignments to b_i and x in an atomic step. In this exercise we consider two variants of Peterson's algorithm. VARIANT 1 is depicted below. We note that there is a fourth location which allows us to do the above mentioned assignments non-atomically. VARIANT 2 is obtained by swapping for each process the statements at locations *nc* and *req*.

	while true {
	.....
nc :	$b_1 := \text{true};$
req :	$x := 2;$
wt :	**wait until**$(x = 1 \vee \neg b_2);$
cs :	... critical section ...
	$b_1 := \text{false};$
	.....
	}

	while true {
	.....
nc :	$b_2 := \text{true};$
req :	$x := 1;$
wt :	**wait until**$(x = 2 \vee \neg b_1);$
cs :	... critical section ...
	$b_2 := \text{false};$
	.....
	}

We say that a variant of Peterson's mutual exclusion algorithm *satisfies the mutual exclusion property* if there is no execution such that both processes are in the critical section at the same time (i.e., the location (cs_1, cs_2) in the interleaving of the program graphs is unreachable).

Analyze for each variant formally if the mutual exclusion property is satisfied. Please perform the following steps.

(a) Draw the program graphs for the single processes.

(b) Construct the interleaving of the program graphs for both processes.

(c) Construct the transition system for the interleaving.

(d) Check if there is some reachable state in which both processes are in the critical section.

In this exercise, you only have to draw the interleaving and the transition system if the variant satisfies the property. In case the property is violated it is also sufficient to provide an execution that shows the violation.