RHEINISCH-
WESTFÄLISCHE
TECHNISCHE
HOCHSCHULE
AACHEN

LEHRSTUHL FÜR INFORMATIK 2
RWTH Aachen · D-52056 Aachen
http://www-i2.informatik.rwth-aachen.de/

Prof. Dr. Ir. J.-P. Katoen
M. Neuhäußer

Introduction to Model Checking
Winter term 08/09

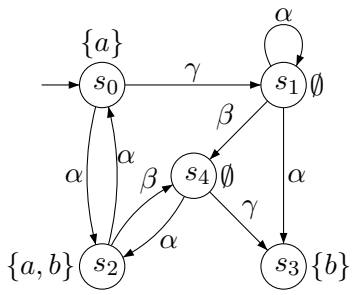
– Series 1 –

Hand in on October 31 before the exercise class.

Exercise 1

(0.5, 0.5, 1 points)

We consider the basic definitions for transition systems. Let TS be the transition system depicted on the right.



a) Give the formal definition of TS.

b) Specify a finite and an infinite execution of TS.

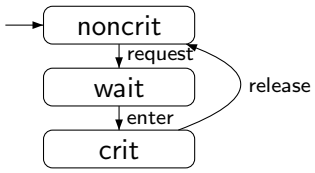
c) Decide whether TS is an AP-deterministic or an action-deterministic transition system. Justify your answer!

Exercise 2

(1 + 2 points)

A concurrent system comprises $P_1, \ldots, P_n$ competing processes (without shared memory) that access common resources within their critical sections. We assume that the resources may only be accessed exclusively and that k equivalent instances are available.
Further, let $n, k \in \mathbb{N}$ with $2 \leq k \leq n$.
Process P_i can be described by a transition system TS_i with three states and the actions $request, enter$ and $release$ as indicated on the right.

TS_i :



a) Develop a transition system representation of an arbiter that communicates with the processes using actions $request$ and $release$. The arbiter should assure that there are no more than k processes within their critical section at the same time.

b) Sketch the transition system of the parallel composition

$$(TS_1 ||| TS_2 ||| TS_3) \parallel_{Syn} Arbiter$$

with $Syn = \{request, release\}$ for $k = 2$. You need not consider the states $wait_i$.

Exercise 3 (2 + 2 points)

Consider the following mutual exclusion algorithm that uses the shared variables y_1 and y_2 (which are initially both 0):

Process P_1:

while true **do**
  ... non-critical section ...
  $y_1 := y_2 + 1$
  wait until $(y_2 = 0) \vee (y_1 \leq y_2)$
  ... critical section ...
  $y_1 := 0$
  ... non-critical section ...
od

Process P_2:

while true **do**
  ... non-critical section ...
  $y_2 := y_1 + 1$
  wait until $(y_1 = 0) \vee (y_2 < y_1)$
  ... critical section ...
  $y_2 := 0$
  ... non-critical section ...
od

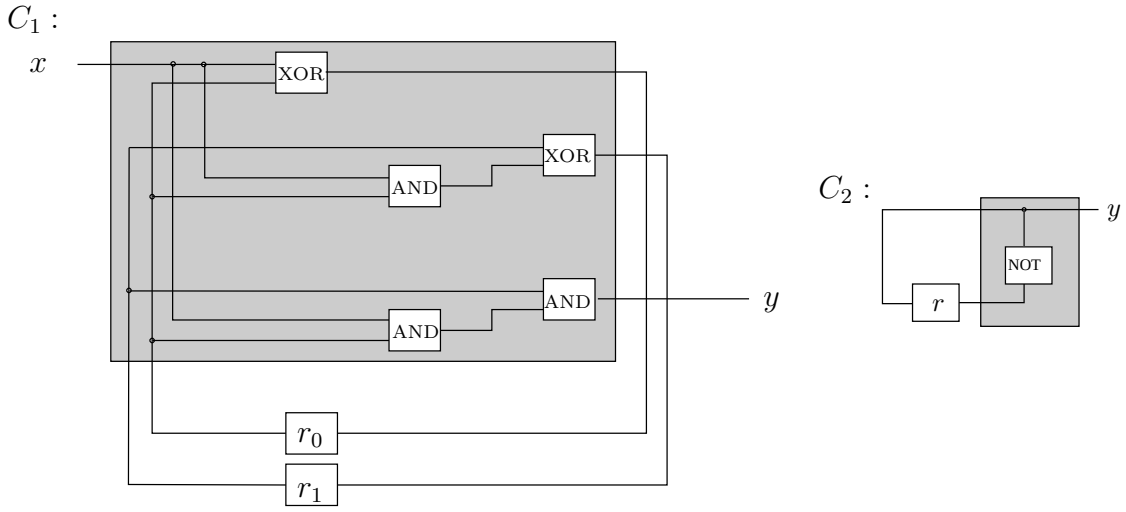
Questions:

a) Give the program graph representation of both processes.
(A pictorial representation suffices)

b) Give the reachable part of the transition system of $P_1|||P_2$ where $y_1 \leq 2$ and $y_2 \leq 2$.

Exercise 4 (2 + 3 points)

The circuit C_1 describes the layout of a hardware adder that stores a 2-bit binary number represented by the registers r_0 and r_1. In each cycle, the value of x is added to the currently stored value; y is used as the carry bit:



a) Give the transition system representation TS_1 of the circuit C_1.

b) Let TS_2 be the transition system of the circuit C_2.
Outline the transition system $TS_1 \otimes TS_2$.