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**LEHRSTUHL FÜR INFORMATIK 2**
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# Introduction to Model Checking
# Winter term 2013/2014

## – Series 1 –

Hand in on October 30th before the exercise class or in the box in front of the chair's secretary's office.

### Exercise 1 (4 points)

Assume $i$ is a natural number. The following process increments $i$ arbitrarily and then decreases the variable to zero. The `nondet()` command non-deterministically returns a boolean value.

**Algorithm 1** Non-deterministic counter

```
while nondet() do
  i := i + 1;
end while
while i > 0 do
  i := i − 1;
end while
```

a) Draw a program graph representation of this process.

b) Draw the corresponding transition system.
*Hint: This is an infinite state system. So you only have to draw it up to some finite depth from where it is clear how it goes on.*

c) Give a precise definition of this transition system (cf. slide 17, lecture 2).

### Exercise 2 (2 points)

We are given three (primitive) processes $P_1, P_2$, and $P_3$ with shared integer variable $x$ and local registers $r_1, r_2$ and $r_3$. The program of process $P_i$ is as follows:

**Algorithm 2** Process $P_i$

```
for k_i = 1, ..., 10 do
  LOAD(r_i ← x);
  INC(r_i);
  STORE(r_i → x);
end for
```

That is, $P_i$ executes ten times the assignment $x := x{+}1$. The assignment $x := x{+}1$ is realized using the three actions LOAD, INC and STORE. Consider now the parallel program:

**Algorithm 3** Parallel program $P$

```
x := 0;
P_1 || P_2 || P_3
```

Question: Does $P$ have an execution that halts with the terminal value $x = 2$? Argue your point.

## Exercise 3 (2 points)

Consider the train crossing example from the lecture (cf. slides 118ff., lecture 3). There it is possible that a train enters a crossing while the gate is open! We alter this system in the following ways:

- A signal is added for the train. The signal can be green or red. The controller changes the signal to green when and only when the track gates are closed. The controller changes the signal to red before opening the gates again.
- The train does not enter the crossing when the signal is red.
- The controller still does not synchronize with the train on an enter action.

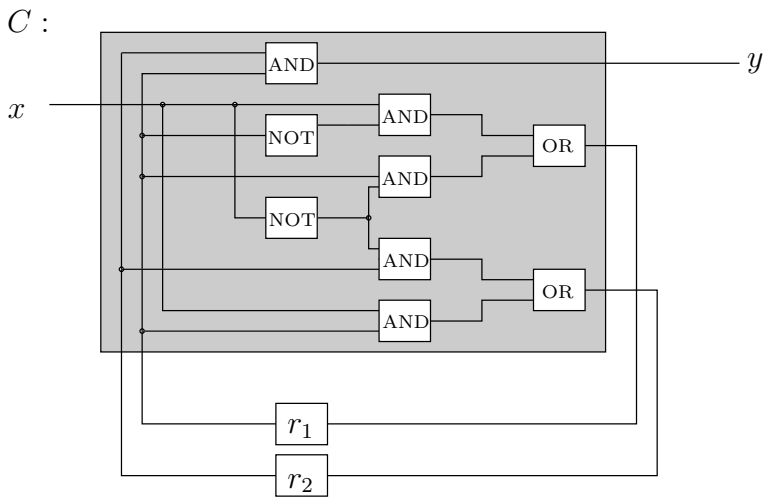
a) Give the transition system representation of controller, gates, signal and train (separately).

b) Give the transition system representation of the combined system.

c) Argue why the train never crosses the road when the train gates are still open.

## Exercise 4 (2 points)

Consider the following sequential hardware circuit:




Give the transition system representation $T$ of the circuit $C$. You need not specify $(S, Act, \rightarrow, I, AP, L)$ - a drawing suffices.