Prof. Dr. Andreas Podelski
Tanja Schindler

Hand in until December 15th, 2017
11:59 via the post boxes
Discussion: December 18th, 2016

# Tutorial for Cyber-Physical Systems - Discrete Models
## Exercise Sheet 8

### Exercise 1: Liveness properties

Let $P$ and $P'$ be liveness properties over $AP$. Prove or disprove the following claims:

(a) $P \cup P'$ is a liveness property.

(b) $P \cap P'$ is a liveness property.

Recall Definition 3.33 from the book:
An LT property $P$ over $AP$ is a liveness property iff $\mathit{pref}(P) = (2^{AP})^*$.

### Exercise 2: LT properties

Recall Exercise 2 from Sheet 6. We considered seven LT properties with $AP = \{a, b\}$.

(a) State for each of these properties which of them are invariants, which are safety properties, which are liveness properties, and which are neither.

(Hint: some properties fall into several classes.)

(b) For those properties $P$ which are neither a safety nor a liveness property, find a decomposition of $P = P_s \cap P_l$ into a safety and a liveness property. Use $\omega$-regular expressions to describe $P_s$ and $P_l$.

For your reference, we list the properties again below.

(i) Always (at any point of time) $a$ or $b$ holds.

(ii) Always (at any point of time) $a$ and $b$ holds.

(iii) Never $b$ holds before $a$ holds.

(iv) Every time $a$ holds there will be eventually a point of time where $b$ holds.

(v) At exactly three points of time, $a$ holds.

(vi) If there are infinitely many points of time where $a$ holds, then there are infinitely many points of time where $b$ holds.

(vii) There are only finitely many points of time where $a$ holds.

### Exercise 3: Traces

Let $TS_{Sem}$ and $TS_{Pet}$ be the transition systems for the semaphore-based mutual exclusion algorithm (Example 2.24 in the book) and Peterson's algorithm (Example 2.25), respectively. Let $AP = \{wait_i, crit_i \mid i = 1, 2\}$. Prove or disprove:

$$\mathit{Traces}(TS_{Sem}) = \mathit{Traces}(TS_{Pet}).$$

If the property does not hold, it is sufficient to give a trace of one transition system that is not a trace of the other transition system.