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

## – Series 3 –

Hand in on November 13th before the exercise class or in the box in front of the chair's secretary's office.

### Exercise 1 (4 points)

Consider the set $AP$ of atomic propositions defined by $AP = \{x = 0, x > 1\}$ and consider a non-terminating sequential computer program $P$ that manipulates the variable $x$. Formulate the following informally stated properties as LT properties:

(a) false

(b) initially $x$ is equal to zero

(c) initially $x$ differs from zero

(d) initially $x$ is equal to zero, but at some point $x$ exceeds one

(e) $x$ exceeds one only finitely many times

(f) $x$ exceeds one infinitely often

(g) the value of $x$ alternates between zero and one

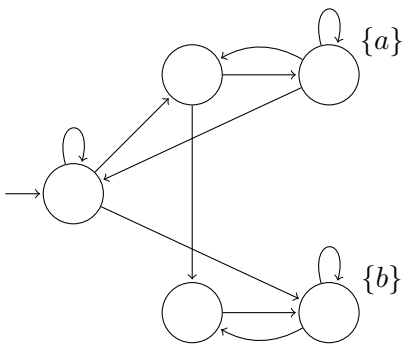
(h) true

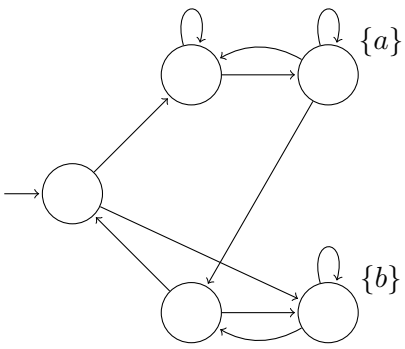
Determine which of the provided LT properties are safety properties. Justify your answers.

### Exercise 2 (2 points)

Consider the two transition systems below. Show that they are not finite trace equivalent!

*Hint: slide 80, lecture 6*



## Exercise 3 (4 points)

For this exercise we give the following definition:

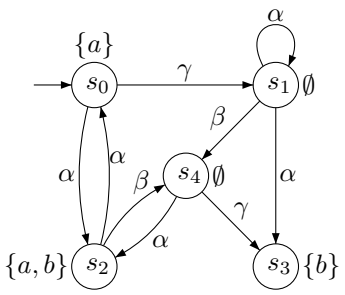
**Definition 1. Deterministic Transition System**

Let $\mathrm{T} = (S, Act, \rightarrow, I, AP, L)$ be a transition system.

- T is called *action-deterministic* if $|\, I \,| \leq 1$ and $|\, Post(s, \alpha) \,| \leq 1$ for all states $s$ and actions $\alpha$.
- T is called *AP-deterministic* if $|\, I \,| \leq 1$ and $|Post(s) \cap \{\, s' \in S \mid L(s') = A \,\}| \leq 1$ for all states $s$ and $A \in 2^{AP}$.

■

Now let $TS$ be the transition system depicted on the right.




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

Let T and T′ be transition systems with the same set of atomic propositions $AP$. Prove the following relationship between trace inclusion and finite trace inclusion:

b) For $AP$-deterministic T and T′:

$$\mathit{Traces}(\mathrm{T}) = \mathit{Traces}(\mathrm{T}') \text{ if and only if } \mathit{Traces}_{\mathit{fin}}(\mathrm{T}) = \mathit{Traces}_{\mathit{fin}}(\mathrm{T}').$$

c) Give concrete examples of T and T′ where at least one of the transition systems is not $AP$-deterministic, and

$$\mathit{Traces}(\mathrm{T}) \not\subseteq \mathit{Traces}(\mathrm{T}') \quad \text{and} \quad \mathit{Traces}_{\mathit{fin}}(\mathrm{T}) = \mathit{Traces}_{\mathit{fin}}(\mathrm{T}').$$