Formal Models SS 2020: Assignment 8

Based on Video "Lecture 15. May 2014" on our webpage.
Institute for Formal Models and Verification, JKU Linz

due 28.05.2020

Guideline:

- To indicate that you solved an exercise, tick it off in our MOODLE course until **10am on the day of the exercise (28.05.2020)**. Unmarking and marking exercises later is **not** possible.
- **Upload your solved exercises in the Moodle course. Generate a single PDF file, which contains all solved exercises, your name, and your matriculation number. Upload the PDF file - do not generate a ZIP!** Not following the format leads to deduction of points!
- We will randomly select and correct solved exercises.
- A sample solution will be provided.

Exercise 29

a) Reformulate $\forall x.\ (\phi \leftrightarrow \psi)$ using only $\exists$ and operators $\neg$ and $\wedge$.

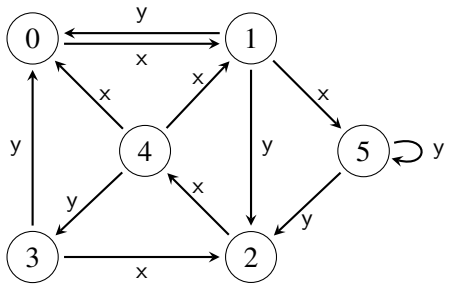
b) Define the semantics of the boolean operators $\neg$, $\wedge$, $\vee$, $\rightarrow$, and $\leftrightarrow$ in Simplified HML analogously to the definitions of the modal operators and boolean constants (see slide 53).

c) Referring to the semantical rules of Simplified HML on slide 53, explain in detail why formula $[a]\,1$ is always true in a state s and why formula $\langle a\rangle\,0$ is always false.

Exercise 30

Given LTS L and Simplified HML formulae 1 to 5 as shown below.

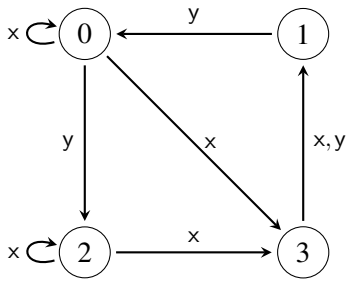
1. $\langle y\rangle\,1$
2. $[x]\,0$
3. $[y]\,[y]\,0$
4. $[y]\,\langle x\rangle\,1$
5. $\langle x\rangle([y]\,0 \wedge \langle x\rangle\,1)$



a) For each state s of L, determine which of the formulae 1 to 5 hold in s.

b) Give the *nesting depth* of modal operators for each formula. What is the significance of the *nesting depth* of a formula in relation to the length of a *trace*.

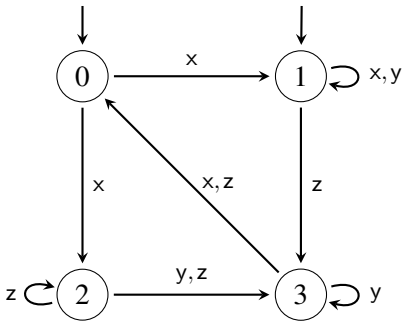
Exercise 31



Given an LTS L as above with $\Sigma = \{x, y, z\}$. Calculate $[[\langle y \rangle 1 \rightarrow ([x]1 \wedge [y]0)]]$.

Exercise 32

Given the LTS L shown in the figure below.



Decide for which states of L the following Simplified HML expressions hold. Put a cross into each cell of the table to indicate that the corresponding formula holds in the corresponding state. Otherwise leave the cell empty.

Simplified HML expression	State 0	State 1	State 2	State 3
$\langle x \rangle \langle x \rangle 1$				
$[x](\langle x \rangle 1 \wedge [y]0)$				
$([x]\langle y \rangle 1) \leftrightarrow ([y]\langle x \rangle 1)$				
$([x \vee y]\langle \neg y \rangle 1) \rightarrow ([y]\langle x \rangle 1)$				

Which of the formulae hold in L?