Formal Models SS 2020: Assignment 10

Based on Video "Lecture 12. June 2014" on our webpage.
Institute for Formal Models and Verification, JKU Linz

due 18.06.2020

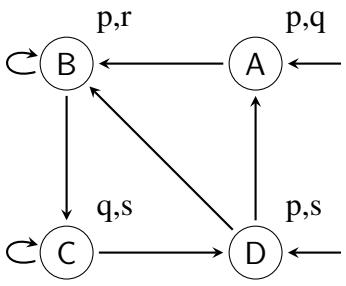
Guideline:

- To indicate that you solved an exercise, tick it off in our MOODLE course until **10am on the day of the exercise (18.06.2020)**. 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 37

Given Kripke structure K. Given trace π and LTL formula f, decide if f holds in π, i.e., $\pi \models f$.

trace π	Formula f	yes	no
$A,B,(C)^\omega$	$\mathbf{GF}r$	☐	☐
$(A,B,C,D)^\omega$	$\mathbf{FG}r$	☐	☐
$D,B,(C)^\omega$	$\mathbf{F}(s \wedge \mathbf{X}q)$	☐	☐
$(D,B,C,D,A,B,C)^\omega$	$\mathbf{GF}(p\ \mathbf{U}\ s)$	☐	☐
$A,(B,C,D)^\omega$	$\mathbf{G}((\mathbf{G}p) \rightarrow (\mathbf{F}s))$	☐	☐



Exercise 38

Given ACTL formula $f := (\mathbf{AX}\ p) \vee \mathbf{AXAX}\ q$, where p and q are atomic propositions ($p, q \in \mathcal{A}$). Draw a Kripke structure K with exactly one initial state such that $K \not\models f$ but $K \models f \setminus \mathbf{A}$
(note that there is such a K with exactly 4 states)!

Is there an LTL formula which is equivalent to f?

Justify your answers.

Exercise 39

Now consider $h := \mathbf{A}\big[(\mathbf{AX}\, p)\, \mathbf{U}\, p\big]$.

First determine an equivalent as simple as possible ACTL formula h' using the semantics of ACTL.

Sketch a computation tree (as in slides 63-65) to support the soundness of this simplification.

Now rewrite h' step by step into an equivalent formula h'' syntactically in ACTL$^{\text{det}}$.

Give the equivalent $h''' := h'' \setminus \mathbf{A}$ formula in LTL.

Exercise 40

Determine if the formula on the left is equivalent to a formula in LTL$^{\text{det}}$ and ACTL$^{\text{det}}$. **If such an equivalent formula exists, then mark (tick off) the box in the second column.** If you mark this box, then give the corresponding formula in LTL$^{\text{det}}$ in the third column, if the formula in the first column is in LTL. If the formula in the first column is in CTL and you marked the box, then add in the third column the corresponding formula in ACTL$^{\text{det}}$.

$p \vee q$	☐	
$\mathbf{EX}\, p$	☐	
$\mathbf{X}(p \vee q)$	☐	
$\mathbf{AX}\, p$	☐	
$p \vee \mathbf{X}\, q$	☐	
$\mathbf{AFAF}\, p$	☐	
$p \vee \mathbf{FX}\, p$	☐	
$\mathbf{AX}p \vee \mathbf{AF}\, p$	☐	
$\neg\mathbf{FG}\, p$	☐	
$\mathbf{A}[(p \vee q)\, \mathbf{U}\, p]$	☐	

Assume that p, q are atomic propositions, i.e., $p, q \in \mathcal{A}$. Further make sure that all the formulas entered in the third column fall syntactically in the corresponding fragment (are generated by the rules in the definition of LTL$^{\text{det}}$ and CTL$^{\text{det}}$).