

“Model checking”

Prof. Dr. Marcel Kyas

Assignment 4, November 13, 2009

Exercise 12 (4 Points) Prove or disprove the following equivalences:

$$\begin{aligned} \Box\varphi \rightarrow \Diamond\psi &\iff \varphi\mathcal{U}(\psi \vee \neg\varphi) \\ \Box\varphi \wedge \bigcirc\Diamond\varphi &\iff \Box\varphi \\ \Box\varphi &\iff \neg(\text{true}\mathcal{U}\neg\varphi) \\ \Diamond\varphi &\iff \text{true}\mathcal{U}\varphi \\ \neg(\varphi\mathcal{U}\psi) &\iff \Box\varphi \vee (\varphi\mathcal{U}(\varphi \wedge \neg\psi)) \end{aligned}$$

Exercise 13 (6 Points) Consider the transition system T over the set of atomic propositions $P = \{a, b, c\}$. Decide for each of the LTL formulae φ_i below, whether $T \models \varphi_i$ holds. Justify

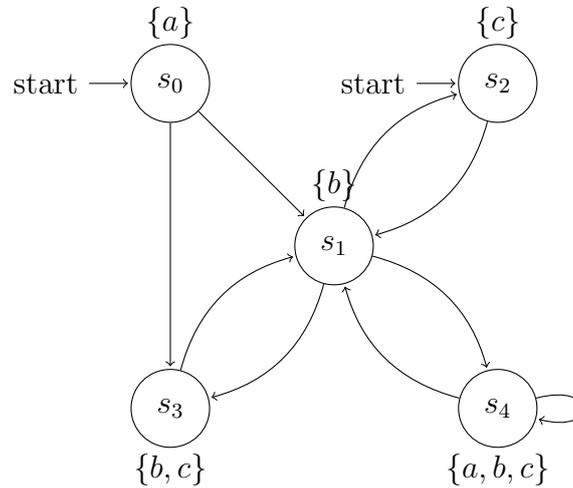


Figure 1: Transition system T

your answers. If $T \not\models \varphi_i$, provide a path π in T such that $\pi \not\models \varphi_i$.

$$\begin{aligned} \varphi_1 &= \Diamond\Box c \\ \varphi_2 &= \Box\Diamond c \\ \varphi_3 &= \bigcirc\neg c \rightarrow \bigcirc\bigcirc c \\ \varphi_4 &= \Box a \\ \varphi_5 &= a\mathcal{U}\Box(b \vee c) \\ \varphi_6 &= (\bigcirc\bigcirc b)\mathcal{U}(b \vee c) \end{aligned}$$

Exercise 14 (4 Points) Consider the GNBA \mathcal{G} below with the alphabet $2^{\{a,b\}}$ and the set $\mathcal{F} = \{\{q_1, q_3\}, \{q_2\}\}$ of accepting sets.

1. Provide a LTL formula φ with $\llbracket\varphi\rrbracket = \mathcal{L}(\mathcal{G})$. Justify your answer.
2. Depict the NBA \mathcal{A} with $\mathcal{L}(\mathcal{A}) = \mathcal{L}(\mathcal{G})$.

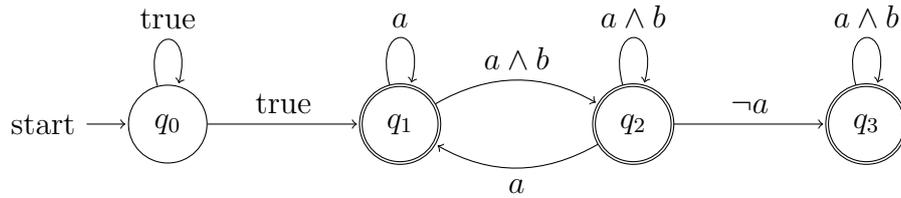


Figure 2: Transition system T

Exercise 15 (6 Points) Let $\varphi = \Box(a \rightarrow \Diamond \neg a)$ and $P = \{a\}$.

1. Transform the formula into an equivalent basic LTL formula ψ , i.e. one that is accepted by the grammar:

$$\varphi ::= true \mid a \mid b \mid \varphi \wedge \varphi \mid \neg \varphi \mid \bigcirc \varphi \mid \varphi \mathcal{U} \varphi$$

2. Compute the closure of your transformed formula ψ .
3. Compute all elementary sets with respect to $closure(\psi)$.
4. Construct the GNBA \mathcal{G}_ψ with $\mathcal{L}(\mathcal{G}_\psi) = \llbracket \psi \rrbracket$. To that end:
 - (a) Define the set of initial states Q_0 and its sets of acceptance sets \mathcal{F} .
 - (b) For each elementary set B , define transition relation.

Handing in this Assignment Please submit your hand-written solutions to exercise 12 on paper no later than November 18, 2009, 18:00 (before the tutorial session).

The models shall be placed in a directory that carries the last name of one of the group members. Add a readme file, or better, a **Makefile**, that explains or automates the modelling and checking procedures. Explain, how to interpret the results of model checking in an accompanying PDF or ASCII file.

Put all this into a tape archive that shares the name with the directory and send it by e-mail to marcel.kyas@fu-berlin.de. Use “Model checking 09 Series 4 *your last names*” as the subject line.