IA169: Model Checking

Seminar 5

Exercise 1 *Recall the definition of* simulation *between two Kripke structures* $M = (S^M, \to^M, S_0^M, L^M)$ *and* $N = (S^N, \to^N, S_0^N, L^N)$.

Simulation relation between M and N is written as $M \leq N$ and is read "N simulates M"

Exercise 2 *Given the following Kripke structures* M_i*, decide for each pair* (M_i, M_j) *such that* $i \neq j$ *whether* $M_i \leq M_j$ *holds. If it does, find the simulation relation. If not, explain why.*

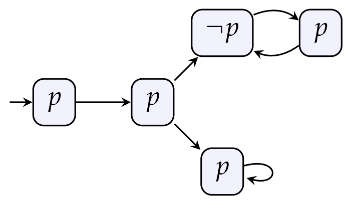

Figure 1: M_1

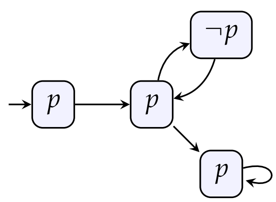

Figure 2: M_2

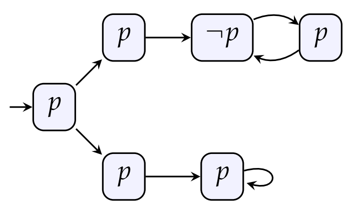

Figure 3: M_3

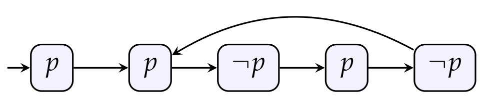

Figure 4: M_4

Exercise 3 *Briefly explain what is a* predicate abstraction M_{may} *of a labeled transition system* M *given a set of predicates* $\mathbb{P}$.

Exercise 4 *Consider the labeled transition system* M *defined by the following description in guarded command language*

$$
\begin{aligned}
V &= \{x, y\}, \\
E &= \{(a, x = 0, x := x + 1), \\
&\quad (b, y = 0, y := y + 1), \\
&\quad (c, x > 0, (x := x + 3, y := y + 3))
\end{aligned}
$$

and a set of predicates

$$\mathbb{P} = \{x > 0, x = y, y > 2\}.$$

Compute the system M_{may} that is the result of predicate abstraction of the system M.

Exercise 5 *Consider the labeled transition system M and the set of predicates $\mathbb{P}$ from Exercise 4. The system satisfies the property $\mathsf{G}(|x - y| \leq 1)$ but the abstract system M_{may} does not. Find a spurious counterexample.*

Try to find a refiniment *of $\mathbb{P}$ that* blocks *the spurious counterexample.*

Exercise 6 *Consider the labeled transition system M defined by the following description in guarded command language*

$$\begin{aligned} V &= \{x, y\}, \\ E &= \{(a, \top, y := y + 10), \\ &\qquad (b, x \bmod 3 = 0, (x := x + 1, y := y + 3)), \\ &\qquad (c, x \bmod 3 = 1, (x := x + 1, y := y + 4)), \\ &\qquad (d, x \bmod 3 = 2, (x := x + 1, y := y - 6))\}. \end{aligned}$$

The system satisfies the property $G(y \geq 0)$. Find a finite set of predicates $\mathbb{P}$ that reduces the system M to a finite-state system M_{may} that also satisfies the property.

Try to find as small $\mathbb{P}$ as possible.