

Model Checking – Sample Solution 7

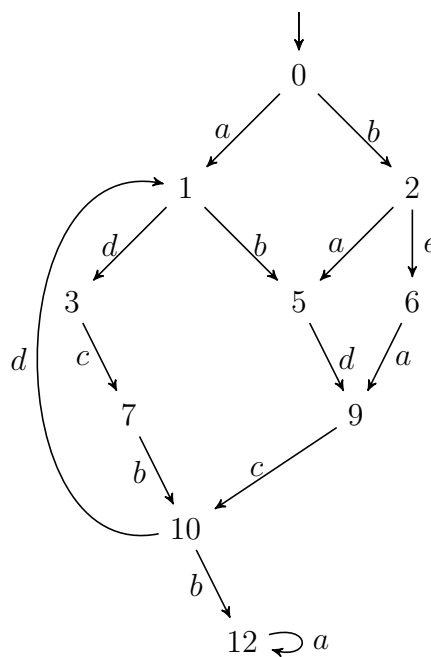
Exercise 7.1

(a) $I = \{ (a, b), (a, c), (a, d), (b, c), (b, e), (c, d), (c, e), (d, e),$
 $(b, a), (c, a), (d, a), (c, b), (e, b), (d, c), (e, c), (e, d) \}$

(b) $U = \{b, c, d\}$

(c) $red(0) = \{a, b\}, red(2) = \{a, e\}, red(5) = \{d\}, red(6) = \{a\}, red(9) = \{c\}, red(10) =$
 $\{d, b\}, red(12) = \{a\}, red(1) = \{b, d\}, red(3) = \{c\}, red(7) = \{b\},$

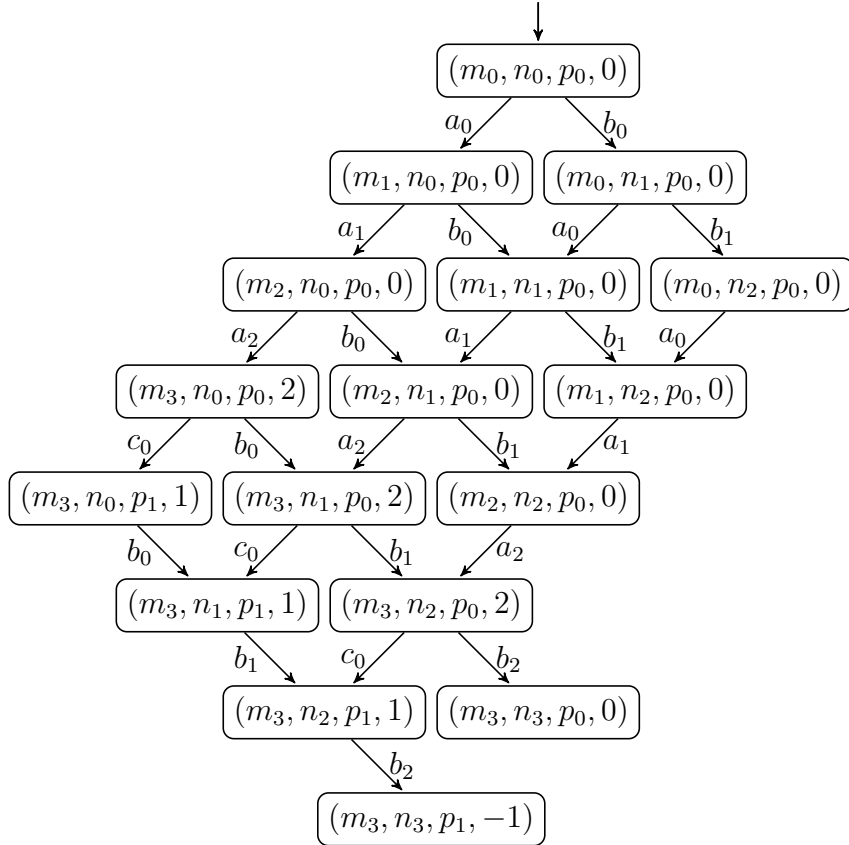
(d)



Exercise 7.2

We define actions $a_0, a_1, a_2, b_0, b_1, b_2$, and c_0 for statements in m, n , and p , respectively. Each state in the Kripke structure is a tuple of program locations and a valuation of g . Notice that it is not necessary to explicitly models valuations of x and y as they are implicitly defined by program locations of m and n .

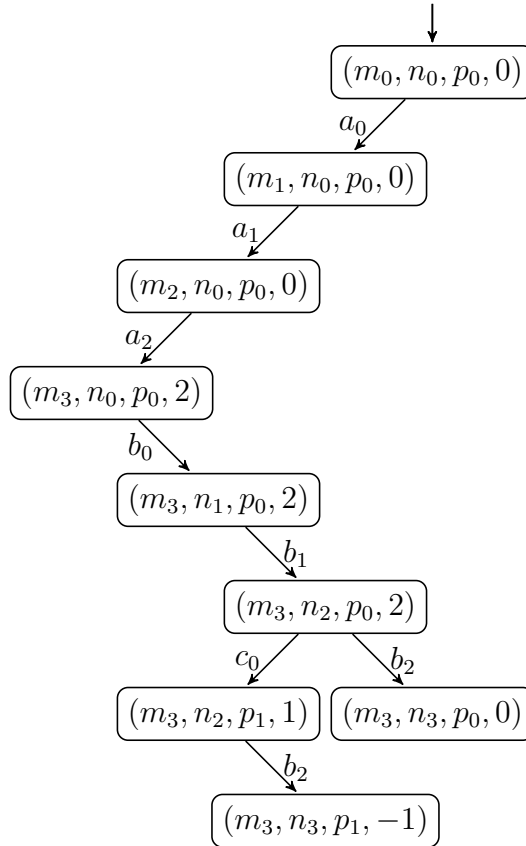
For each property, we construct a labeled Kripke structure $\mathcal{K} = (S, A, \rightarrow, r, AP, \nu)$, where S, A, \rightarrow , and r are as follows:



The independence relation $I = (A \times A \setminus Id) \setminus \{(b_2, c_0), (c_0, b_2)\}$.

Next, we consider each property individually.

- a) The corresponding LTL formula is $\mathbf{F}(g == 1)$, where $AP_a = \{g == 1\}$. So, $\nu_a(s) = \{g == 1\}$ iff the valuation of g in the state s is 1, and as a result, $U = A \setminus \{b_2, c_0\}$. A possible reduced Kripke structure is as follows:



- b) The corresponding LTL formula is $m_1 \mathbf{R} \neg n_3$, where $AP_b = \{m_1, n_3\}$. $\nu_b(s) = \{m_1\}$ (resp. $\{n_3\}$) iff the s contains m_1 (resp. $\{n_3\}$). As a result, $U = A \setminus \{a_0, a_1, b_2\}$. A possible reduced Kripke structure is as follows:

