**Technische Universität München (I7)** **Summer Semester 2016**
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# Model Checking – Sample Solution 7

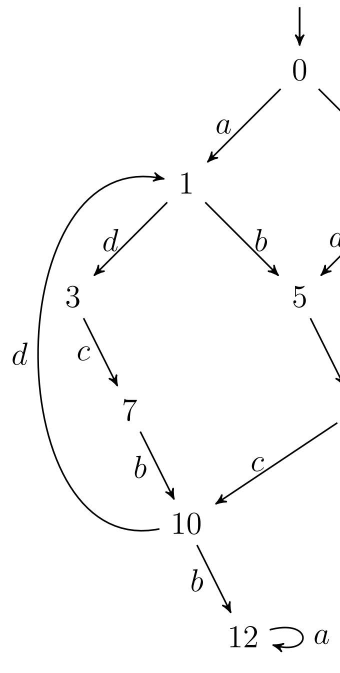
**Exercise 7.1**

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

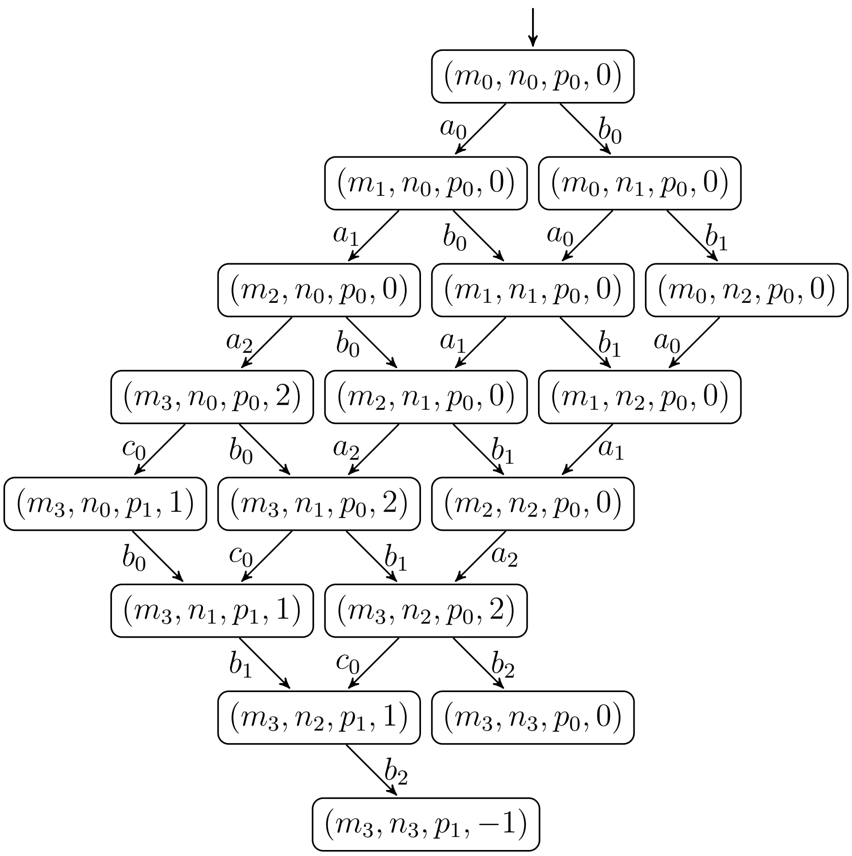
(d)



**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`.

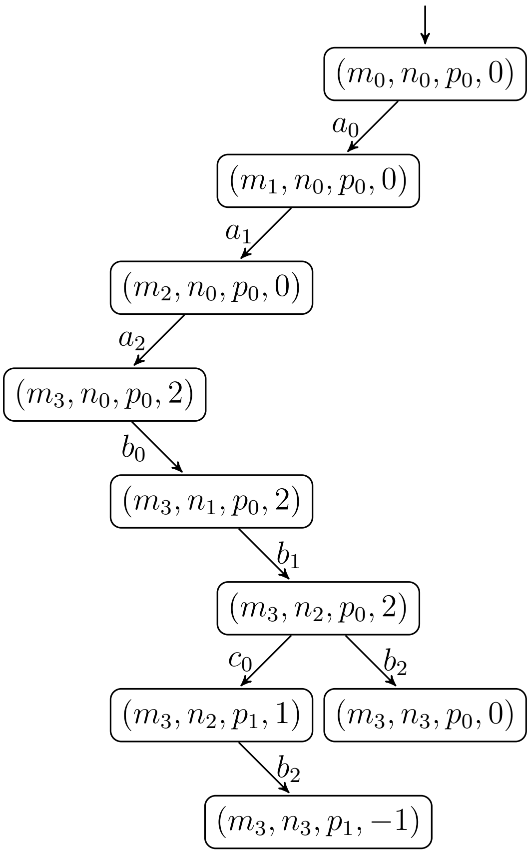
For each property, we construct a labeled Kripke structure $\mathcal{K} = (S, A, \rightarrow, r, AP, \nu)$, where and $S$, $A$, $\rightarrow$, and $r$ are as follows:




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 $\mathbf{F}(\mathtt{g} == 1)$, where $AP_a = \{\mathtt{g} == 1\}$. So, $\nu_a(s) = \{\mathtt{g} == 1\}$ iff the valuation of $\mathtt{g}$ 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: