Master of Science in Computer Science - University of Camerino
Systems Verification Lab A. Y. 2018/2019
Written Test of 12th September 2019 (Appello VI)
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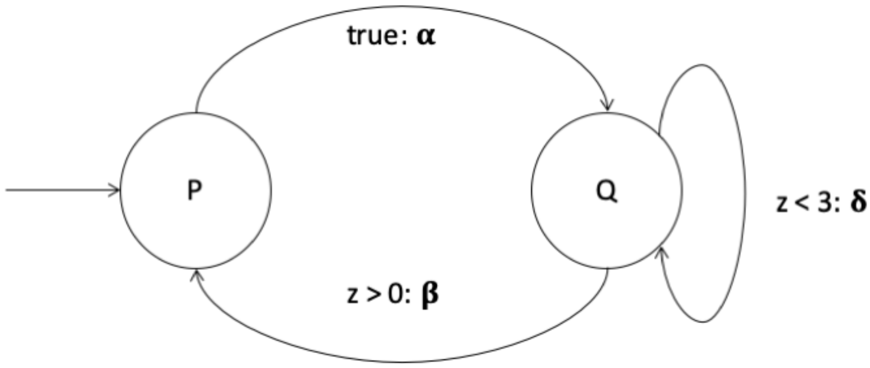
EXERCISE 1 (8 points)

Consider the following program graph



where z is a variable such that $\text{dom}(z) = \{0, 1, 2, 3\}$, $g_0 \equiv (z = 1)$, $\text{Loc}_0 = \{P\}$, $\mathit{Effect}(\alpha, \eta) = \eta[z := 0]$, $\mathit{Effect}(\beta, \eta) = \eta[z := \eta(z) - 1]$ and $\mathit{Effect}(\delta, \eta) = \eta[z := \eta(z) + 1]$.

1. Translate the given program graph into an equivalent transition system.

EXERCISE 2 (8 points)

Consider the atomic propositions $AP = \{A, B\}$ and the following linear time properties:

(a) Whenever A holds then B holds after two steps

(b) A and B hold together infinitely many times

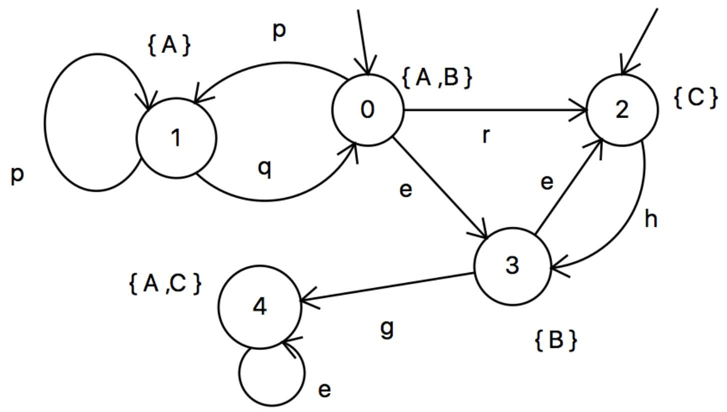
(c) A holds once and B never holds

For each property:

1. formalise it using set expressions and first order logic;
2. formalise it in LTL (you can use the operators next, until, box and diamond, together with all boolean connectives);
3. tell if it is a safety, liveness or mixed property. In case it is a pure safety property provide an NFA for the language of the **minimal bad prefixes**.

EXERCISE 3 (8 points)

Consider the following transition system TS on $AP = \{A, B, C\}$.



Decide whether or not the following LTL formulas:

$$\varphi_0 = \Box(C \to \Diamond A) \qquad \varphi_1 = \Diamond(B \wedge \bigcirc(B \vee C))$$
$$\varphi_2 = \Box\Diamond\neg B$$

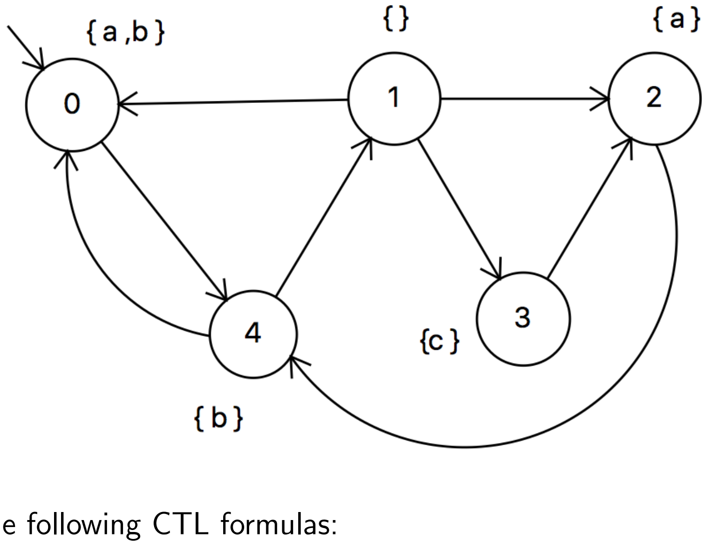
are satisfied by TS under the following fairness conditions (to be considered separately):

$$\psi_0^{\text{fair}} = (\{\}, \{\}, \{\}) \qquad \psi_1^{\text{fair}} = (\{\}, \{\{g\}, \{e, r\}\}, \{\{q\}\})$$
$$\psi_2^{\text{fair}} = (\{\}, \{\}, \{\{g\}, \{e\}, \{q\}\})$$

Justify your answers! In case the answer is no, provide a counterexample.

EXERCISE 4 (8 points)

Consider the following transition system TS on $AP = \{a, b, c\}$.



Decide whether or not the following CTL formulas:

$$\phi_0 = \forall\Diamond c \qquad \phi_1 = \exists\Diamond(b \wedge \exists \bigcirc \neg b)$$
$$\phi_2 = \forall\Box(a \to \forall\Diamond b) \qquad \phi_3 = \forall\Box(\neg b \to \forall \bigcirc (a \vee b))$$

are satisfied by TS. Justify your answers! When possible, provide a counterexample or a witness.