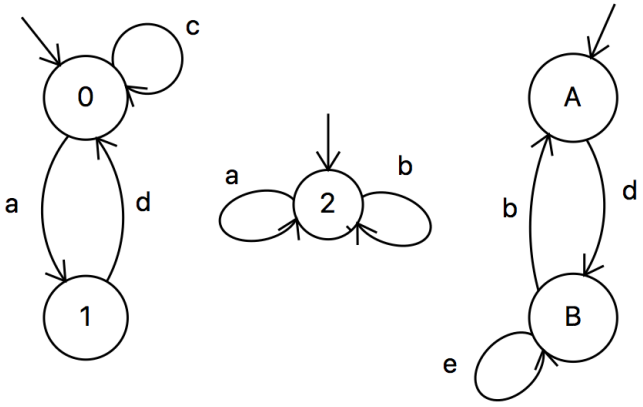
Master of Science in Computer Science - University of Camerino
Reactive Systems Verification A. Y. 2017/2018
Written Test of 1st February 2018 (Appello I)
Teacher: Luca Tesei

EXERCISE 1 (7 points)

Consider the three following transition systems (initial states: 0, 2 and A).



1. Draw the transition system resulting from their product using handshaking with the handshake action set $H = \{a, b, d\}$.

EXERCISE 2 (9 points)

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

(a) Whenever A holds then B holds immediately and in the next step

(b) B holds infinitely many times and C holds only finitely many times

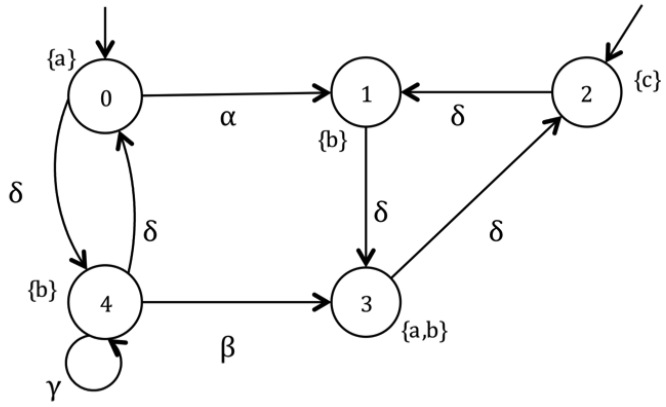
(c) A holds at least twice and whenever B holds also C must hold

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**. In case it is a pure liveness property provide an NBA for the language of **bad behaviours**.

EXERCISE 3 (8 points)

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



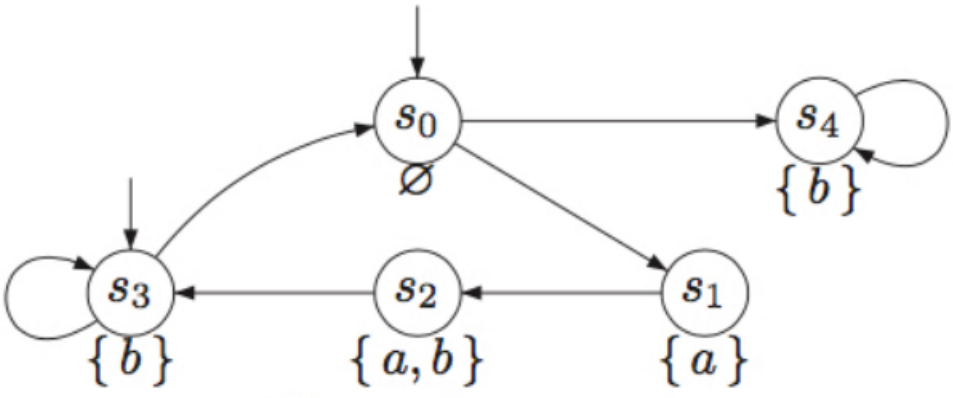
1. Decide whether or not the LTL formula $\varphi = \Diamond(b \,\mathcal{U}\, c)$ is satisfied by the transition system, under the following fairness conditions (to be considered separately):

$$\psi_1^{\text{fair}} = \{\{\}, \{\gamma\}, \{\}\} \qquad \psi_2^{\text{fair}} = \{\{\}, \{\}, \{\alpha\}\}$$
$$\psi_3^{\text{fair}} = \{\{\}, \{\alpha, \beta\}, \{\}\} \qquad \psi_4^{\text{fair}} = \{\{\}, \{\alpha\}, \{\gamma\}\}$$

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

EXERCISE 4 (8 points)

Consider the following transition system



1. Calculate $\mathrm{Sat}(\forall(a \,\mathcal{U}\, b) \vee \exists \bigcirc (\forall \Box b))$ Justify your answers by showing the steps of the algorithm used for the CTL formulas.