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Problem Set 1
Discussion Session: 30th of October 2012

Automata, Games, and Verification

Please contact Markus Rabe in case you can't make it to the discussion session on the specified time slot

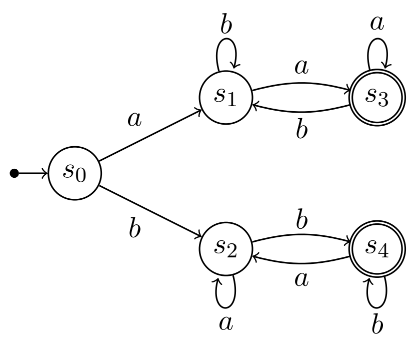
1. **Concurrent game structures and Temporal Logics** (Group G13, Discussion Session at 12:00)

   In this assignment your task is to model and specify a protocol for managing a parking lot. A controller manages a barrier at the entrance of the parking lot. When a car approaches the barrier, the controller decides whether to open the barrier or not.
   Formalize the protocol as a concurrent game structure using the atomic propositions {*outside, inside, open, request*} and express each of the following statements using one of the logics introduced in the lecture. (Try to use the least expressive logic.)

   a) The car will never enter the parking lot.
   b) It is possible that the car stays always outside the parking lot.
   c) The car enters the parking lot definitively.
   d) No matter how the controller behaves, the car can decide to stay outside the parking lot.
   e) No matter how the car behaves, the controller can prevent the car from entering the parking lot.

2. **Büchi automata and non-accepting words** (Group G02, Discussion Session at 12:20)

   For the following automaton, find out whether there exist words that are not accepted by the automaton.



   In case of a positive answer (there is a non-accepted word), state the word and reason informally why it is not accepted. In case of a negative answer, reason informally why there is no word that is not accepted.

3. **Büchi automata** (Group G08, Discussion Session at 12:40)

   Build complete Büchi automata for each of the following ω-languages with alphabet $\Sigma = \{a, b\}$, for $(a), (b)$ and (c) give also an LTL formula:

   a) $L_1 = \{\alpha \in \Sigma^\omega \mid \text{each occurence of } a \text{ in } \alpha \text{ is followed immediately by a } b\}$
   b) $L_2 = \{\alpha \in \Sigma^\omega \mid \text{the letter } a \text{ occurs infinitely often in } \alpha\}$
   c) $L_3 = \{\alpha \in \Sigma^\omega \mid \text{the letter } b \text{ occurs finitely often in } \alpha\}$

d) $L_4 = L_1 \cap L_2$

e) $L_5 = L_2 \cup L_3$

f) $L_6 = L_1 \cap L_2 \cap L_3$

4. **Selection on Büchi automata (Challenge)**

Given a Büchi recognizable language L_{pick} over alphabet $\{1, 2\}$ and two Büchi recognizable languages L_1, L_2 over alphabet Σ, show that the following language L_{choose} (over the alphabet Σ) is also Büchi recognizable:

$$\begin{aligned} L_{choose} \quad = \quad & \{\delta_0\delta_1\delta_2 \ldots \in \Sigma^\omega \mid \\ & \text{there exists } \sigma_0^1\sigma_1^1\sigma_2^1 \ldots \in L_1, \sigma_0^2\sigma_1^2\sigma_2^2 \ldots \in L_2, \gamma_0\gamma_1\gamma_2 \ldots \in L_{pick} \text{ such that} \\ & \text{for all } i \in \mathbb{N}_0, \delta_i = \sigma_i^{\gamma_i}\} \end{aligned}$$