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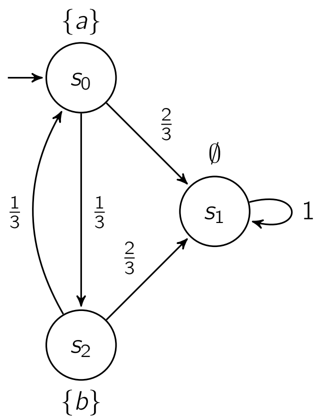
Exercise 1 (ω-regular Properties): (4 points)

Non-deterministic Büchi automata are strictly more expressive than deterministic ones. Recall the "powerset construction", which is used to compute a deterministic finite automaton from a non-deterministic one.

a) Construct a non-deterministic Büchi automaton for the language $(a+b)^* a^\omega$, apply the powerset construction to determinize this automaton, and compare the languages of the resulting automaton and the original one by either showing their equivalence or giving a counterexample separating the languages.

b) Consider the following DTMC D:



Give a formal definition for the cross-product between a *non-deterministic* Büchi-Automaton and a DTMC. Apply this definition to the DTMC D and the NBA from a). What problems arise?

Exercise 2 (Probabilities vs. Qualitative Properties): (3 points)

Let $D = (S, \mathbf{P}, s_{init}, AP, L)$ be a finite DTMC, $s \in S$, $a, b \in AP$. For each of the following statements, explain informally whether it is correct or not. If it is not correct, give a counterexample and indicate which of the implications (if any) hold.

a) $Pr(s \models \Box a) = 1$ if and only if $s \models \forall \Box a$

b) $Pr(s \models \Diamond a) < 1$ if and only if $s \not\models \forall \Diamond a$

c) $Pr(s \models \Box a) > 0$ if and only if $s \models \exists \Box a$

Exercise 3 (Algorithms for Qualitative Model Checking): (3 points)

Let $D = (S, \mathbf{P}, s_{init}, AP, L)$ be a finite DTMC and $a, b \in AP$. Give algorithms (in pseudocode) to compute the following sets and briefly explain the complexity of your algorithm.

a) $S_{=0} = \{s \in S \mid Pr(s \models a \mathrm{U} b) = 0\}$

b) $S_{=1} = \{s \in S \mid Pr(s \models a \mathrm{U} b) = 1\}$