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Problem Set 4
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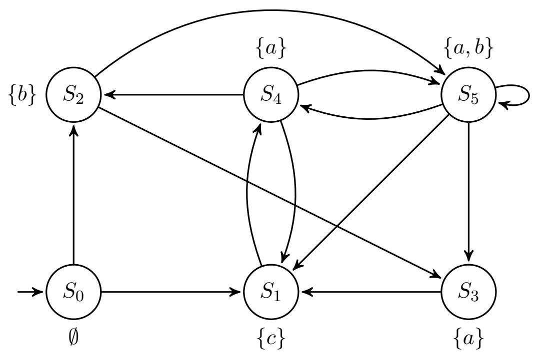
Verification

Problem 1: Linear Time Properties [8 Points]

1. Express the following informal Linear Time Properties over $AP = \{a, b, c\}$ formally and provide a justification.
   a) There is no a before the first b
   b) If there are infinitely many occurrences of a followed by b in the next step, there must be only finitely many c's
   c) Every b is be eventually followed by a non-empty sequence of a's that is terminated by a c
   d) There are infinitely many a's and every a is followed by a, b or c
2. Prove for each property in 1. that the following transition system satisfies the property or give a counterexample.



Problem 2: Paths and Linear Time Properties [4 Points]

In the lecture, the following theorem was stated (slide 18, lecture 6) for two transition systems TS and TS':

$$\begin{gathered} \mathit{Traces}(TS) \subseteq \mathit{Traces}(TS') \\ \text{if and only if for any LT property } P \\ TS' \models P \text{ implies } TS \models P \end{gathered}$$

Give a proof for the theorem.

The following exercises belong to the afternoon session.

Problem 3: Characterization of Linear Time Properties [4 Points]

For every LT property in Problem 1 argue whether it is a *safety* or *liveness* property, or neither of them. In the latter case, decompose the LT property into a conjunction of a safety and a liveness property.

Problem 4: Liveness and Safety Property [2 Points]

Prove that $(2^{AP})^\omega$ is the only LT property that is both a *safety* and a *liveness* property.