Principles of Model Checking
Exercise class 2

Verification of regular linear time properties

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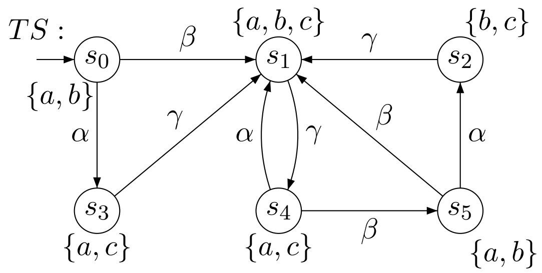
Problem 1

Consider the following transition system TS



and the regular safety property

$$P_{safe} = \begin{array}{l}\text{"always if } a \text{ is valid and } b \wedge \neg c \text{ was valid somewhere before,} \\ \text{then neither } a \text{ nor } b \text{ does hold thereafter at least until } c \text{ holds"}\end{array}$$

As an example, we have:

$$\begin{aligned}
\{b\}\varnothing\{a, b\}\{a, b, c\} &\in \mathit{pref}(P_{safe}) \\
\{a, b\}\{a, b\}\varnothing\{b, c\} &\in \mathit{pref}(P_{safe}) \\
\{b\}\{a, c\}\{a\}\{a, b, c\} &\in \mathit{BadPref}(P_{safe}) \\
\{b\}\{a, c\}\{a, c\}\{a\} &\in \mathit{BadPref}(P_{safe})
\end{aligned}$$

1. Draw an NFA $\mathcal{A}$ such that $\mathcal{L}(\mathcal{A}) = \mathit{MinBadPref}(P_{safe})$.
2. Decide whether $TS \models P_{safe}$, using the $TS \otimes \mathcal{A}$ construction. Provide a counterexample if $TS \not\models P_{safe}$.

Problem 2

For each of the ω-regular languages below, give a nondeterministic Büchi automaton accepting it.

1. $L_1 = \{\sigma \in \{A, B\}^\omega \mid \sigma$ contains ABA infinitely often, but AA only finitely often$\}$
2. $L_2 = \mathcal{L}_\omega\left((AB + C)^*((AA + B)C)^\omega + (A^*C)^\omega\right)$

   Hint: nondeterministic Büchi automata can have multiple initial states.

Problem 3

Let $\mathcal{A}_1$ and $\mathcal{A}_2$ be NBA over the same alphabet Σ. Prove (without using GNBAs) that there exists am NBA $\mathcal{A}$ such that

$$\mathcal{L}_\omega(\mathcal{A}) = \mathcal{L}_\omega(\mathcal{A}_1) \cap \mathcal{L}_\omega(\mathcal{A}_2).$$