Software Validation and Verification
Second Exercise Sheet

Exercise 1

Consider the set $AP = \{a, b\}$ of atomic propositions. Formulate the following properties as LT properties and characterize each of them as being either an invariance, safety property, or liveness property, or none of these:

1. the atomic proposition a never occurs in the trace;
2. a occurs exactly once;
3. a and b alternate infinitely often;
4. if a is present, then it is eventually followed by b.

Exercise 2

Let E and E' be liveness properties. Prove or disprove the following claims:

1. $E \cup E'$ is a liveness property;
2. $E \cap E'$ is a liveness property.

Exercise 3

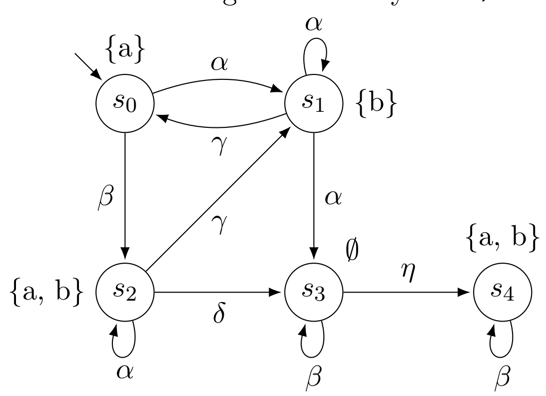
Let $AP = \{a, b\}$ and let E be the LT property of all infinite words $\sigma = A_0A_1A_2 \ldots \in (2^{AP})^\omega$ such that there exists $n \geq 0$ with $a \in A_i$ for $0 \leq i < n$ and $\{a, b\} = A_n$. Provide a decomposition into a safety and a liveness property $E = E_{safe} \cap E_{live}$.

Exercise 4

Let E denote the set of traces of the form $\sigma = A_0A_1A_2 \ldots \in (2^{AP})^\omega$ such that

$$\overset{\infty}{\exists} k.A_k = \{a, b\} \ \wedge \ \exists n.\forall k \geq n.(a \in A_k \implies b \in A_{k+1}).$$

Consider the following transition system $\mathcal{T}$:



Consider the following fairness assumptions $\mathcal{F}_1, \mathcal{F}_2$ in the form $(\mathcal{F}_{uncond}, \mathcal{F}_{strong}, \mathcal{F}_{weak})$:

$$\mathcal{F}_1 = (\{\{\alpha\}\}, \{\{\beta\}, \{\gamma, \delta\}, \{\eta\}\}, \emptyset) \qquad \mathcal{F}_2 = (\{\{\alpha\}\}, \{\{\beta\}, \{\gamma\}\}, \{\eta\})$$

1. Decide whether $\mathcal{T} \models_{\mathcal{F}_1} E$;
2. Decide whether $\mathcal{T} \models_{\mathcal{F}_2} E$.