**Exercise 1 (Stutter bisimulation quotient):** (1+3+1 points)

Consider the following transition system $T_S$.

(a) Depict the divergence-sensitive expansion $T_S$.

(b) Determine the divergence-stutter-bisimulation quotient $T_S/\approx$. Apply the algorithm and give for each iteration the partition of the state space.

(c) Depict $T_S/\approx^{div}$.

**Exercise 2 (Simulation relation):** (3 points)

Consider the given transition systems.

For each $i, j \in \{1..3\} \times \{1..3\}, i \neq j$ determine whether $T_S_i \preceq T_S_j$. Justify your answer (e.g. by giving the simulation relation).
Exercise 3 (Stutter simulation): \(0.5+0.5+0.5+0.5\) points

Let \(T S_i = (S_i, Act_i, \rightarrow_i, I_i, AP, L_i), i = 1, 2\) be two finite transition systems. A stutter simulation for \((T S_1, T S_2)\) is a relation \(R \subseteq S_1 \times S_2\) such that:

(A) \(\forall s_1 \in I_1 \exists s_2 \in I_2 : (s_1, s_2) \in R\)

(B) For all \((s_1, s_2) \in R\) the following conditions hold:

1. \(L_1(s_1) = L_2(s_2)\).
2. If \(s'_1 \in Post(s_1)\) with \((s'_1, s_2) \notin R\), then there exists a finite path fragment \(s_1 s_2 u_1 \ldots u_n s'_2\) with \(n \geq 0\) and \((s_i, u_i) \in R, i = 1, \ldots, n\) and \((s'_1, s'_2) \in R\).

\(T S_1\) is said to be stutter simulated by \(T S_2\), denoted \(T S_1 \lesssim_{st} T S_2\), iff there exists a stutter simulation for \((T S_1, T S_2)\).

(a) Provide example transition systems \(T S_1, T S_2\), such that \(T S_1 \not\lesssim_{st} T S_2\) but \(T S_1 \lesssim_{st} T S_2\).

(b) Provide example transition systems \(T S_1, T S_2\), such that \(T S_1 \not\lesssim_{st} T S_2\) but \(T S_1 \not\lesssim_{st} T S_2\).

(c) Provide example transition systems \(T S_1, T S_2\), such that \(T S_1 \not\lesssim_{st} T S_2\) but \(T S_1 \not\lesssim_{st} T S_2\).

(d) Provide example transition systems \(T S_1, T S_2\), such that \(T S_1 \not\approx T S_2\) but \(T S_1 \lesssim_{st} T S_2\) and \(T S_2 \lesssim_{st} T S_1\).