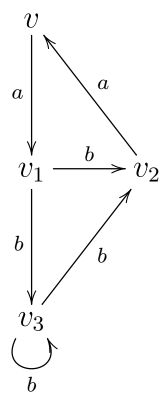
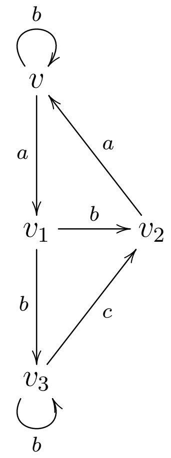
Exercise 1



Consider the labelled transition system above. Compute the relation $\sim$ of strong bisimilarity (union of all strong bisimulation relations) as a maximum fixed point.

Exercise 2*



Determine (using both the fixed-point computation as well as using games) whether the following recursively defined variable X holds in a given state of the LTS above (note the added b loop in v and the new action c). Try to formulate the properties below intuitively and argue why a minimum or maximum fixed point was used.

1. $X \overset{min}{=} [a]f\!f \vee \langle a \rangle X, \quad v_2 \overset{?}{\models} X$
2. $X \overset{min}{=} (\langle a \rangle tt \wedge \langle b \rangle tt) \vee \langle a \rangle X \vee \langle b \rangle X, \quad v_1 \overset{?}{\models} X$
3. $X \overset{min}{=} [a]f\!f \vee (\langle a \rangle X \wedge [b]f\!f), \quad v_2 \overset{?}{\models} X$
4. $X \overset{max}{=} \langle b \rangle X \wedge [c]f\!f, \quad v \overset{?}{\models} X$
5. $X \overset{max}{=} ([a]f\!f \vee [b]f\!f) \wedge [a]X \wedge [b]X, \quad v_1 \overset{?}{\models} X$

Exercise 3

Express the following properties as formulae in HML with one recursively defined variable and argue for the choice of minimum or maximum fixed point.

1. There is an infinite path consisting of only actions a and b.
2. There is an infinite path consisting of only actions a and b where the first action is a and where a and b alternate.
3. One can reach a state where the action sequence aba is enabled.
4. One can reach a state where the action sequence aba is enabled and before this happens, the action c is always enabled.