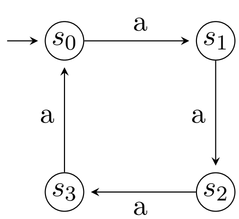
Concurrent Programming - Exercícios 1

Labeled Transition Systems

1. What are the values of x after the execution of the program? How many diferent executions there are?

   $x \leftarrow 10; ((x \leftarrow 2x; x \leftarrow x - 1; x \leftarrow x + 2) \,||x \leftarrow x - 5)$

2. Consider the following LTS

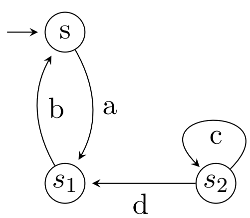
   (a) Define the LTS as a triple $(S, \longrightarrow, s_0)$ and determine Act.

   (b) Draw the reflexive closure of the binary relation $\xrightarrow{a}$.

   (c) Draw the symmetric closure of the binary relation $\xrightarrow{a}$.

   (d) Draw the transitive closure of the binary relation $\xrightarrow{a}$.

3. Let the LTS

   (a) Define the LTS as a triple $(S, \longrightarrow, s)$ and the set Act.

   (b) Compute $Post(s_1)$ and $Act(s_2)$

   (c) Determine $Reach(s_2)$.

4. Let $Post^0(s) = \{s\}$ and $Post^{n+1}(s) = Post(Post^n(s))$, show that

$$Reach(s) = \bigcup_n Post^n(s).$$

5. Let $\longrightarrow^\star \subseteq S \times Act^\star \times S$ be the reflexive and transitive closure of $\longrightarrow$, show that $s \xrightarrow{\omega}^\star s'$ iff $s' \in Reach(s)$, where $\omega = \alpha_1 \cdots \alpha_n$ for some $\alpha_i \in Act$. Hint: By induction on n.

6. For each of the following machines build a LTS that models its behaviour.

   (a) A machine that given a coin produce coffee

   (b) A machine that given a coin produce coffee or tea

   (c) A machine that given a coin one can push a button that allows to choose between coffee or tea

   (d) A machine as in the previous case but that after producing two beverages stops.

(e) A machine that given a coin produce coffee but may also not give coffee and return to the initial state

7. Solve the problems of LTSs in PseuCo.com.

8. Two LTS $TS = (S, \longrightarrow, s_0)$ and $TS' = (S', \longrightarrow', s'_0)$ are isomorphic, $TS \sim TS'$, it there exists a bijection f,

$$f : Reach(TS) \to Reach(TS')$$

with

- $f(s_0) = s'_0$
- for all $s_1, s_2 \in Reach(TS)$ and for all $\alpha \in Act$

$$s_1 \xrightarrow{\alpha} s_2 \quad \textit{iff} \quad f(s_1) \xrightarrow{\alpha}{}' f(s_2)$$

(a) Show that the LTS isomorphism is a equivalence relation

(b) Show that a LTS that is finitely branching and that has a finite number of states is isomorphic to a finite-state LTS.