Formal methods for system verification

Exercise 1

Consider the web service provided by Netflix which can serve the requests of different customers. Each customer may play a locally available video with probability p_1 or play a video available on a remote web server of Netflix with probability $p_2 = 1 - p_1$. The local activities of the customers can be carried out independently of the web service. In contrast, the customer and the web service will cooperate when the customer requires a video offered by Netflix. Cooperation over given actions is reflected in the parallel composition by the cooperation set, $L = \{request, respond\}$.

$$\begin{array}{lcl} \mathit{Netflix} & \stackrel{\text{def}}{=} & (request, \top).(serve, \mu).(respond, \top).\mathit{Netflix} \\ \mathit{Client} & \stackrel{\text{def}}{=} & (play, p_1\lambda).(local, m).\mathit{Client} + (play, p_2\lambda).(request, rq).(respond, rp).\mathit{Client} \\ \mathit{System}_1 & \stackrel{\text{def}}{=} & \mathit{Client} \underset{L}{\bowtie} \mathit{Netflix} \end{array}$$

where $L = \{request, respond\}$.

(a) Define the set of current action types $\mathcal{A}(\mathit{Client})$.

(b) Define the set of current action types $\mathcal{A}(\mathit{System_1})$.

(c) Define $r_{play}(\mathit{Client})$ that is the apparent rate of action type *play* in the *Client* component.

(d) Define $r_{request}(\mathit{Client})$ that is the apparent rate of action type *request* in the $\mathit{System_1}$ component.

(e) Define the activity multiset $\mathcal{A}ct(\mathit{Client})$.

(f) Define the activity multiset $\mathcal{A}ct(\mathit{System_1})$.

(g) Draw the derivation graph of the *Client* component.

(h) Draw the derivation graph of the *Netflix* component.

(i) Draw the derivation graph of the $\mathit{System_1}$ component.

Exercise 2

Consider now

$$\begin{array}{lcl} \mathit{Client}' & \stackrel{\text{def}}{=} & \mathit{Client}/\{local\} \\ \mathit{System}_2 & \stackrel{\text{def}}{=} & (\mathit{Client}' \| \mathit{Client}') \underset{L}{\bowtie} \mathit{Netflix} \end{array}$$

where $L = \{request, respond\}$.

(a) Define the set of current action types $\mathcal{A}(\mathit{System_2})$.

(b) Define $r_{play}(\mathit{System_2})$ that is the apparent rate of action type *play* in the $\mathit{System_2}$ component.

(c) Define the activity multiset $\mathcal{A}ct(\mathit{System_2})$.

Exercise 3

Consider now

$$\begin{array}{lcl} \mathit{Client}'' & \stackrel{\text{def}}{=} & (request, rq).(respond, rp).\mathit{Client}'' \\ \mathit{System}_3 & \stackrel{\text{def}}{=} & (\mathit{Client}'' \| \mathit{Client}'') \underset{L}{\bowtie} \mathit{Netflix} \end{array}$$

where $L = \{request, respond\}$.

(a) Define $r_{request}(\mathit{Client}'' \| \mathit{Client}'')$ that is the apparent rate of action type *request* in the Client'' component.

(b) Define $r_{request}(\mathit{System_3})$ that is the apparent rate of action type *request* in the $\mathit{System_3}$ component.

(c) Define the activity multiset $\mathcal{A}ct(\mathit{Client}'' \| \mathit{Client}'')$.

(d) Define the activity multiset $\mathcal{A}ct(\mathit{System_3})$.