Formal methods for system verification

Exercise 1

Consider the following simple client-server system:

$$\begin{array}{lcl} Client & \stackrel{\text{def}}{=} & (use, \top).(think, \mu).Client \\ Server & \stackrel{\text{def}}{=} & (use, \lambda).(reset, \gamma).Server \\ ClientSystem & \stackrel{\text{def}}{=} & Client \underset{\{use\}}{\bowtie} Server \end{array}$$

(a) Draw the derivation graph of $ClientSystem$.

(b) Define the infinitesimal generator matrix $\mathbf{Q}$ of the Markov process underlying the $ClientSystem$ component.

(c) Write the global balance equations for $ClientSystem$.

(d) Write the formula to compute the utilisation of the server.

(e) Write the formula to compute the throughput of *use*.

Exercise 2

Consider the one-client system:

$$\begin{array}{lcl} Server' & \stackrel{\text{def}}{=} & (Server)/\{reset\} \\ ClientSystem' & \stackrel{\text{def}}{=} & Client \underset{\{use\}}{\bowtie} Server' \end{array}$$

Assuming that $\lambda = 2$, $\mu = 8$ and $\gamma = 6$

(f) Draw the derivation graph of $ClientSystem'$.

(g) Define the infinitesimal generator matrix $\mathbf{Q}$ of the Markov process underlying the $ClientSystem'$ component.

(h) Compute the throughput of *use*.

Exercise 3

A system with two clients competing for the same server is represented as:

$$2ClientSystem \stackrel{\text{def}}{=} (Client||Client) \underset{\{use\}}{\bowtie} Server'$$

(i) Draw the derivation graph of $2ClientSystem$.

(l) Define the infinitesimal generator matrix $\mathbf{Q}$ of the Markov process underlying the $2ClientSystem$ component.

(m) Write the global balance equations for $2ClientSystem$.

(n) Write the formula to compute the utilisation of the server.