

Concurrent Programming - Exercises 6

Value passing CCS

1. For each process P compute the LTS $\llbracket P \rrbracket$

(a) $(a!21.0|a?x.b!(x * 2).0) \setminus \{a\}$

(b) $(a!42.0|a?x.Sender[x]) \setminus \{a\}$

2. For the following program compute its LTS.

$$\begin{aligned}
 Sender &:= put?x.send!x.Sending[x] \\
 Sending[x] &:= receiveAck?.Sender + receiveNAck?.send!x.Sending[x] \\
 Receiver &:= receive?x.get!x.sendAck!.Receiver + \\
 &\quad garbled?.sendNAck!.Receiver \\
 Medium &:= send?x.(receive!x.Medium + i.garbled!.Medium) \\
 AckMedium &:= sendAck?.receiveAck!.AckMedium + \\
 &\quad sendNAck?.receivedNAck!.AckMedium \\
 DupMedium &:= Medium|AckMedium \\
 Protocol &:= (Sender | Receiver | DupMedium) \setminus \\
 &\quad \{send, receive, sendAck, receiveAck, \\
 &\quad receiveNAck, sendNAck, garbled\}
 \end{aligned}$$

Compute also $\llbracket (Protocol|put!1.put!2.put!3.put!4.0) \setminus \{put\} \rrbracket$. Restrict the values to $rangeR := 0..9$.

3. Given

$$\begin{aligned}
 Fac[n, j] &:= when(j > 0)i.Fac[n * j, j - 1] \\
 &\quad +when(j == 0)println!n.0
 \end{aligned}$$

Compute $\llbracket Fac[1, 5] \rrbracket$.

4. Consider the following vending machine that accepts coins of 1, 2 and 5 euros. If the price of a coffee has not been paid yet, more coins are required before a coffee is dispensed. Once enough money has been paid, no more coins are accepted, and a coffee is dispensed. If the last inserted coin caused the coffee to be overpaid, some change is given. Each coffee cost 5 euros.

$$\begin{aligned}
 Machine[b] &:= when(b < 5)coin?c.Machine[b + c] + when(b \geq 5)coffee!.ReturnMachine[b - 1] \\
 ReturnMachine[b] &:= when(b > 0)change!.ReturnMachine[b - 1] + Machine[0] \\
 User &:= coin!2.coin!2.coin!2.coffee?.change?.0
 \end{aligned}$$

Construct $\llbracket (Machine[0]|User) \setminus \{coin, change, coffee\} \rrbracket$.

5. Given

$$\begin{aligned} \text{Cell}[rd, wr, x] &:= rd!x.\text{Cell}[rd, wr, x] + wr?y.\text{Cell}[rd, wr, y] \\ \text{Cells} &:= \text{Cell}[rdA, wrA, 0]|\text{Cell}[rdB, wrB, 0] \\ \text{Serve} &:= mult?.rdA?x : R.rdB?y : R.IterMult[0, x, y] \\ \text{IterMult}[z, x, y] &:= \text{when}(x > 0)i.\text{IterMult}[z + y, x - 1, y] \\ &\quad +\text{when}(x == 0)\text{println!}z.\text{Serve} \\ \text{Use} &:= wrA!7.wrB!5.mult!.0 \end{aligned}$$

Compute $\llbracket(\text{Cells}|\text{Serve}|\text{Use}) \setminus \{rdA, wrA, rdB, wrB, mult\}\rrbracket$.

6. Consider the exercise 9 from Practical 5 with value passing CCS.