Design-by-Contract and Behavioural Types

Assessment

- Gay, S., Hole, M. Subtyping for session types in the pi calculus. *Acta Informatica* 42, 191–225 (2005). https://doi.org/10.1007/s00236-005-0177-z.

  1. Consider the following session types

  $$\begin{aligned}
  \texttt{Tester}_1 &= \&[\texttt{Pr} : \texttt{?int.!bool.end}, \texttt{Co} : \texttt{?int.?int.!bool.end}]\\
  \texttt{Tester}_2 &= \&[\texttt{Pr} : \texttt{?int.!bool.end}, \texttt{Co} : \texttt{?int.end}]\\
  \texttt{Tester}_3 &= \&[\texttt{Pr} : \texttt{?int.!bool.end}]\\
  \texttt{Client}_1 &= \oplus[\texttt{Pr} : \texttt{!int.?bool.end}, \texttt{Co} : \texttt{!int.!int.?bool.end}]\\
  \texttt{Client}_2 &= \oplus[\texttt{Pr} : \texttt{!int.?bool.end}]
  \end{aligned}$$

  and the subtyping relation for non-recursive types introduced in Fig. 8. Indicates which of the following pairs are in relation. Justify.

     a) $\texttt{Tester}_1 \leq \texttt{Tester}_2$
     b) $\texttt{Tester}_2 \leq \texttt{Tester}_1$
     c) $\texttt{Tester}_1 \leq \texttt{Tester}_3$
     d) $\texttt{Tester}_3 \leq \texttt{Tester}_1$
     e) $\texttt{Client}_1 \leq \texttt{Client}_2$
     f) $\texttt{?Client}_1\texttt{.end} \leq \texttt{?Client}_2\texttt{.end}$
     g) $\texttt{?Client}_2\texttt{.end} \leq \texttt{?Client}_1\texttt{.end}$
     h) $\texttt{!Client}_1\texttt{.end} \leq \texttt{!Client}_2\texttt{.end}$
     i) $\texttt{!Client}_2\texttt{.end} \leq \texttt{!Client}_1\texttt{.end}$

  2. Consider the following process

  $$P_{\texttt{server}} = x^{+} \triangleright [\texttt{Pr} : x^{+}?(y{:}\texttt{int}).x^{+}!\texttt{true}.0]$$

  and the typing system obtained by substituting the rule `[T-branch]` presented in lectures by the rule `[T-offer]` in Figure 9. Indicates which of the following judgements holds.

     a) $x^{+} : \texttt{Tester}_1 \vdash P_{\texttt{server}}$
     b) $x^{+} : \texttt{Tester}_2 \vdash P_{\texttt{server}}$
     c) $x^{+} : \texttt{Tester}_3 \vdash P_{\texttt{server}}$

- Neykova R., Yoshida N. (2019) Featherweight Scribble. In: Boreale M., Corradini F., Loreti M., Pugliese R. (eds) Models, Languages, and Tools for Concurrent and Distributed Programming. *Lecture Notes in Computer Science*, vol 11665. Springer. https://link.springer.com/chapter/10.1007/978-3-030-21485-2_14

  - Different from the global types discussed in the course, programs in Scribble does not specify channels. Which is the underlying communication model in Scribble programs?
  - According to Scribble semantics, does the choreography `a(S) from A to B;b(S) from A to C` ensure that `B` receives the message `a` from `A` before `C` receives `b`?
  - Consider the translation from Scribble to MST in Definition 4.7. Note that the translation uses a definition of global types that differs from the one presented in lectures (Feb. 24). Modify the encoding for the forms `a(S) from A to B;G` and `choice at A` $\{\texttt{a}_j(\texttt{S}_j)$ `from A to B;` $\texttt{G}_j\}_{j\in\{1..n\}}$.
  - Provide an example to illustrates the differences between the projection of choices introduced in the lectures and the one provided in the paper (Definition 4.10).

- Ugo de'Liguoro, Luca Padovani: Mailbox Types for Unordered Interactions. ECOOP 2018: 15:1-15:28. https://drops.dagstuhl.de/opus/volltexte/2018/9220/pdf/LIPIcs-ECOOP-2018-15.pdf

  1. Exhibit a process in the mailbox calculus that

     a) has a deadlock.
     b) is deadlock-free but not fairly terminating.

2. Discuss similarities and differences between the syntax of mailbox types and session types.
3. Indicates if the following processes are well-typed? In the affirmative case give the typing context:
   - $P_1 = u\,\texttt{!}\,\texttt{m}[1] \mid u\,\texttt{!}\,\texttt{m}[2] \mid u\,\texttt{?}\,\texttt{m}(x)\,\texttt{.}\,\texttt{done}$
   - $P_2 = u\,\texttt{!}\,\texttt{m}[1] \mid u\,\texttt{?}\,\texttt{m}(x)\,\texttt{.}\,u\,\texttt{?}\,\texttt{m}(y)\,\texttt{.}\,\texttt{done}$
   - $P_3 = u\,\texttt{!}\,\texttt{m}[1] \mid u\,\texttt{?}\,\texttt{m}(x)\,\texttt{.}\,u\,\texttt{?}\,\texttt{m}(y)\,\texttt{.}\,\texttt{free}\ u\,\texttt{.}\,\texttt{done}$
   - $P_4 = u\,\texttt{!}\,\texttt{m}[1] \mid u\,\texttt{!}\,\texttt{m}[2] \mid u\,\texttt{?}\,\texttt{m}(x)\,\texttt{.}\,u\,\texttt{?}\,\texttt{m}(y)\,\texttt{.}\,\texttt{done}$
   - $P_5 = u\,\texttt{!}\,\texttt{m}[1] \mid u\,\texttt{!}\,\texttt{m}[2] \mid u\,\texttt{?}\,\texttt{m}(x)\,\texttt{.}\,u\,\texttt{?}\,\texttt{m}(y)\,\texttt{.}\,\texttt{free}\ u\,\texttt{.}\,\texttt{done}$
   - $P_6 = u\,\texttt{!}\,\texttt{m}_1[1] \mid u\,\texttt{!}\,\texttt{m}_2[2] \mid u\,\texttt{?}\,\texttt{m}_1(x)\,\texttt{.}\,u\,\texttt{?}\,\texttt{m}_2(y)\,\texttt{.}\,\texttt{free}\ u\,\texttt{.}\,\texttt{done}$
   - $P_7 = u\,\texttt{!}\,\texttt{m}_1[1] \mid u\,\texttt{!}\,\texttt{m}_2[2] \mid u\,\texttt{?}\,\texttt{m}_1(x)\,\texttt{.}\,\texttt{done} + u\,\texttt{?}\,\texttt{m}_2(y)\,\texttt{.}\,\texttt{done}$
   - $Q_i = (\nu u)P_i$