Software Engineering, Exercise Sheet 3

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Exercise 1

- $L_1 \equiv \emptyset \mid (x \approx \emptyset \vdash 1 : \mathtt{int}), (b \approx y : \mathtt{int} \vdash y > 0 : \mathtt{bool})$
  L_1 is not a well-formed linkset because there is no fragment y but a local assumption y. Hence, L_1 is neither intra-checked nor inter-checked.
- $L_2 \equiv \emptyset \mid (x \approx \emptyset \vdash 1 : \mathtt{int}), (b \approx \emptyset \vdash y > 0 : \mathtt{bool})$
  L_2 is a well-formed linkset but it is not an intra-checked linkset because $\emptyset \vdash y > 0 : \mathtt{bool}$ is not derivable. Hence, L_2 is not inter-checked.

Exercise 1 (con't)

- $L_3 \equiv y : \texttt{bool} \mid (x \approx \emptyset \vdash 1 : \texttt{int}),$
  $(b \approx x : \texttt{int} \vdash y > 0 : \texttt{bool})$
  L_3 is well-formed. It is, however, not intra checked because $y : \texttt{bool}, x : \texttt{int} \vdash y > 0 : \texttt{bool}$ is not derivable. Hence, L_3 is not inter-checked.
  If we change the global environment from $y : \texttt{bool}$ to $y : \texttt{int}$, then we arrive at a linkset that is well-formed, intra-checked, and inter-checked.
- $L_4 \equiv \emptyset \mid (x \approx \emptyset \vdash \texttt{true} : \texttt{bool}), (y \approx x : \texttt{int} \vdash x + 1 : \texttt{int})$ is well-formed and intra-checked. It is, however, not inter-checked because fragment x has type $\texttt{bool}$ but the local environment for fragment y assumes that x has type $\texttt{int}$.

Exercise 2

$$
\begin{aligned}
L_1 &\equiv x : \texttt{int} \mid (b \approx y : \texttt{int} \vdash x > y : \texttt{bool}), (y \approx \emptyset \vdash 5 : \texttt{int}) \\
L_2 &\equiv b : \texttt{bool}, z : \texttt{int} \mid (x \approx \emptyset \vdash \texttt{if}\ b\ \texttt{then}\ z\ \texttt{else}\ 0 : \texttt{int}) \\
L_1 + L_2 &\equiv z : \texttt{int} \mid (b \approx x : \texttt{int}, y : \texttt{int} \vdash x > y : \texttt{bool}), \\
&\qquad (y \approx x : \texttt{int} \vdash 5 : \texttt{int}), \\
&\qquad (x \approx b : \texttt{bool} \vdash \texttt{if}\ b\ \texttt{then}\ z\ \texttt{else}\ 0 : \texttt{int})
\end{aligned}
$$

Exercise 3

$$
\begin{aligned}
& z : \mathtt{int} \mid (b \approx y : \mathtt{bool}, x : \mathtt{int} \vdash \mathtt{if}\ y\ \mathtt{then}\ x\ \mathtt{else}\ z : \mathtt{int}), \\
& \qquad (y \approx x : \mathtt{int} \vdash x > 5 : \mathtt{bool}), \\
& \qquad (x \approx \emptyset \vdash 6 : \mathtt{int}) \\
\rightsquigarrow & z : \mathtt{int} \mid (b \approx y : \mathtt{bool}, x : \mathtt{int} \vdash \mathtt{if}\ y\ \mathtt{then}\ x\ \mathtt{else}\ z : \mathtt{int}), \\
& \qquad (y \approx \emptyset \vdash 6 > 5 : \mathtt{bool}), \\
& \qquad (x \approx \emptyset \vdash 6 : \mathtt{int}) \\
\rightsquigarrow & z : \mathtt{int} \mid (b \approx x : \mathtt{int} \vdash \mathtt{if}\ 6 > 5\ \mathtt{then}\ x\ \mathtt{else}\ z : \mathtt{int}), \\
& \qquad (y \approx \emptyset \vdash 6 > 5 : \mathtt{bool}), \\
& \qquad (x \approx \emptyset \vdash 6 : \mathtt{int}) \\
\rightsquigarrow & z : \mathtt{int} \mid (b \approx \emptyset \vdash \mathtt{if}\ 6 > 5\ \mathtt{then}\ 6\ \mathtt{else}\ z : \mathtt{int}), \\
& \qquad (y \approx \emptyset \vdash 6 > 5 : \mathtt{bool}), \\
& \qquad (x \approx \emptyset \vdash 6 : \mathtt{int})
\end{aligned}
$$

Exercise 3 (con't)

Define

$$L = \emptyset \mid (x \approx \emptyset \vdash 5 : \texttt{int}), (y \approx x : \texttt{bool} \vdash x : \texttt{bool})$$

and

$$L' = \emptyset \mid (x \approx \emptyset \vdash 5 : \texttt{int}), (y \approx \emptyset \vdash 5 : \texttt{bool})$$

Then $L \rightsquigarrow L'$, *intra-checked*(L), but not *intra-checked*(L') because $\emptyset \vdash 5 : \texttt{bool}$ is not derivable.
Note that not *inter-checked*(L).

Exercise 4

- $x : \texttt{int} \vdash (y : \texttt{int} = x + 23, z : \texttt{bool} = y < 42) \therefore (y : \texttt{int}, z : \texttt{bool})$
- $x : \texttt{int} \mid (y \approx \emptyset \vdash x + 23 : \texttt{int}), (z \approx y : \texttt{int} \vdash y < 42 : \texttt{bool})$