

TH2 - Übung 2

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1 CSP Trace Semantik

1.1 Traces für konkrete Prozesse berechnen

Gegeben seien die folgenden Prozesse:

$$P = (a \rightarrow b \rightarrow Skip) \square (b \rightarrow d \rightarrow Stop)$$

$$Q = (x \rightarrow Skip) \triangle (y \rightarrow Stop)$$

$$R = (P; Q) \setminus \{x, y\}$$

$$S = P \parallel [\{a, b\} \mid \{x, y\}] \parallel Q$$

Berechnen Sie die Trace-Semantik der Prozesse auf der Basis der Trace-Definitionen im CSP-Guide (Kap. 6). Geben Sie die für die Berechnung verwendeten Regeln an. Referenzversion ist Version 43 des CSP-Guide.

$$P = (a \rightarrow b \rightarrow \text{Skip}) \sqcap (b \rightarrow d \rightarrow \text{Stop})$$

$$\begin{aligned} \text{traces}(P) &= \text{traces}((a \rightarrow b \rightarrow \text{Skip}) \sqcap (b \rightarrow d \rightarrow \text{Stop})) \\ &= \text{traces}(a \rightarrow b \rightarrow \text{Skip}) \cup \text{traces}(b \rightarrow d \rightarrow \text{Stop}) \quad \text{Choice, 6.14} \end{aligned}$$

$$\text{traces}(a \rightarrow b \rightarrow \text{Skip}) = \{\langle \rangle\} \cup \{\langle a \rangle \frown tr \mid tr \in \text{traces}(b \rightarrow \text{Skip})\} \quad \text{Prefixing, 6.10}$$

$$\begin{aligned} \text{traces}(b \rightarrow \text{Skip}) &= \{\langle \rangle\} \cup \{\langle b \rangle \frown tr \mid tr \in \text{traces}(\text{Skip})\} \quad \text{Prefixing, 6.10} \\ &= \{\langle \rangle\} \cup \{\langle b \rangle \frown tr \mid tr \in \{\langle \rangle, \langle \checkmark \rangle\}\} \quad \text{Skip, 6.4} \\ &= \{\langle \rangle, \langle b \rangle, \langle b, \checkmark \rangle\} \end{aligned}$$

$$\begin{aligned} \text{traces}(a \rightarrow b \rightarrow \text{Skip}) &= \{\langle \rangle\} \cup \{\langle a \rangle \frown tr \mid tr \in \{\langle \rangle, \langle b \rangle, \langle b, \checkmark \rangle\}\} \\ &= \{\langle \rangle, \langle a \rangle, \langle a, b \rangle, \langle a, b, \checkmark \rangle\} \end{aligned}$$

$$\text{traces}(b \rightarrow d \rightarrow \text{Stop}) = \{\langle \rangle\} \cup \{\langle b \rangle \frown tr \mid tr \in \text{traces}(d \rightarrow \text{Stop})\} \quad \text{Prefixing, 6.10}$$

$$\begin{aligned} \text{traces}(d \rightarrow \text{Stop}) &= \{\langle \rangle\} \cup \{\langle d \rangle \frown tr \mid tr \in \text{traces}(\text{Stop})\} \quad \text{Prefixing, 6.10} \\ &= \{\langle \rangle\} \cup \{\langle d \rangle \frown tr \mid tr \in \{\langle \rangle\}\} \quad \text{Stop, 6.3} \\ &= \{\langle \rangle, \langle d \rangle\} \end{aligned}$$

$$\begin{aligned} \text{traces}(b \rightarrow d \rightarrow \text{Stop}) &= \{\langle \rangle\} \cup \{\langle b \rangle \frown tr \mid tr \in \{\langle \rangle, \langle d \rangle\}\} \\ &= \{\langle \rangle, \langle b \rangle, \langle b, d \rangle\} \end{aligned}$$

$$\begin{aligned} \text{traces}(P) &= \{\langle \rangle, \langle a \rangle, \langle a, b \rangle, \langle a, b, \checkmark \rangle\} \cup \{\langle \rangle, \langle b \rangle, \langle b, d \rangle\} \\ &= \{\langle \rangle, \langle a \rangle, \langle a, b \rangle, \langle a, b, \checkmark \rangle, \langle b \rangle, \langle b, d \rangle\} \end{aligned}$$

$$Q = (x \rightarrow Skip) \triangle (y \rightarrow Stop)$$

$$\begin{aligned} traces(Q) &= traces((x \rightarrow Skip) \triangle (y \rightarrow Stop)) \\ &= traces(x \rightarrow Skip) \cup \\ &\quad \{tr_1 \frown tr_2 \mid tr_1 \in traces(x \rightarrow Skip) \wedge \checkmark \notin \sigma(tr_1) \wedge tr_2 \in traces(y \rightarrow Stop)\} \quad \text{Interrupt, 6.53} \end{aligned}$$

$$\begin{aligned} traces(x \rightarrow Skip) &= \{\langle \rangle\} \cup \{\langle x \rangle \frown tr \mid tr \in traces(Skip)\} && \text{Prefixing, 6.10} \\ &= \{\langle \rangle\} \cup \{\langle x \rangle \frown tr \mid tr \in \{\langle \rangle, \langle \checkmark \rangle\}\} && \text{Skip, 6.4} \\ &= \{\langle \rangle, \langle x \rangle, \langle x, \checkmark \rangle\} \end{aligned}$$

$$\begin{aligned} traces(y \rightarrow Stop) &= \{\langle \rangle\} \cup \{\langle y \rangle \frown tr \mid tr \in traces(Stop)\} && \text{Prefixing, 6.10} \\ &= \{\langle \rangle\} \cup \{\langle y \rangle \frown tr \mid tr \in \{\langle \rangle\}\} && \text{Stop, 6.3} \\ &= \{\langle \rangle, \langle y \rangle\} \end{aligned}$$

$$\begin{aligned} traces(Q) &= \{\langle \rangle, \langle x \rangle, \langle x, \checkmark \rangle\} \cup \\ &\quad \{tr_1 \frown tr_2 \mid tr_1 \in \{\langle \rangle, \langle x \rangle, \langle x, \checkmark \rangle\} \wedge \checkmark \notin \sigma(tr_1) \wedge tr_2 \in \{\langle \rangle, \langle y \rangle\}\} \\ &= \{\langle \rangle, \langle x \rangle, \langle x, \checkmark \rangle\} \cup \{\langle \rangle, \langle y \rangle, \langle x \rangle, \langle x, y \rangle\} \\ &= \{\langle \rangle, \langle x \rangle, \langle x, \checkmark \rangle, \langle y \rangle, \langle x, y \rangle\} \end{aligned}$$

$$R = (P; Q) \setminus \{x, y\}$$

$$\begin{aligned} \text{traces}(R) &= \text{traces}((P; Q) \setminus \{x, y\}) \\ &= \{tr \setminus \{x, y\} \mid tr \in \text{traces}(P; Q)\} \end{aligned} \quad \text{Hiding, 6.48}$$

$$\begin{aligned} \text{traces}(P; Q) &= \{tr \mid tr \in \{\langle \rangle, \langle a \rangle, \langle a, b \rangle, \langle a, b, \checkmark \rangle, \langle b \rangle, \langle b, d \rangle\} \wedge \checkmark \notin \sigma(tr)\} \\ &\quad \cup \{tr_1 \frown tr_2 \mid tr_1 \frown \langle \checkmark \rangle \in \{\langle \rangle, \langle a \rangle, \langle a, b \rangle, \langle a, b, \checkmark \rangle, \langle b \rangle, \langle b, d \rangle\} \wedge \\ &\quad \quad tr_2 \in \{\langle \rangle, \langle x \rangle, \langle x, \checkmark \rangle, \langle y \rangle, \langle x, y \rangle\}\} \\ &= \{\langle \rangle, \langle a \rangle, \langle a, b \rangle, \langle b \rangle, \langle b, d \rangle\} \cup \\ &\quad \{tr_1 \frown tr_2 \mid tr_1 \in \{\langle a, b \rangle\} \wedge tr_2 \in \{\langle \rangle, \langle x \rangle, \langle x, \checkmark \rangle, \langle y \rangle, \langle x, y \rangle\}\} \\ &= \{\langle \rangle, \langle a \rangle, \langle a, b \rangle, \langle b \rangle, \langle b, d \rangle\} \cup \\ &\quad \{\langle a, b \rangle, \langle a, b, x \rangle, \langle a, b, x, \checkmark \rangle, \langle a, b, y \rangle, \langle a, b, x, y \rangle\} \\ &= \{\langle \rangle, \langle a \rangle, \langle a, b \rangle, \langle b \rangle, \langle b, d \rangle, \langle a, b, x \rangle, \langle a, b, x, \checkmark \rangle, \langle a, b, y \rangle, \langle a, b, x, y \rangle\} \end{aligned} \quad \text{Seq. Comp., 6.51}$$

$$\begin{aligned} \text{traces}(R) &= \{\langle \rangle, \langle a \rangle, \langle a, b \rangle, \langle b \rangle, \langle b, d \rangle, \langle a, b, x \rangle, \langle a, b, x, \checkmark \rangle, \langle a, b, y \rangle, \langle a, b, x, y \rangle\} \setminus \{x, y\} \\ &= \{\langle \rangle, \langle a \rangle, \langle a, b \rangle, \langle b \rangle, \langle b, d \rangle, \langle a, b, \checkmark \rangle\} \end{aligned}$$

$$S = P \parallel [\{a, b\} \mid \{x, y\}] \parallel Q$$

$$\begin{aligned}
traces(S) &= \{tr \in TRACES \mid tr \upharpoonright \{a, b, \checkmark\} \in traces(P) \wedge \\
&\quad tr \upharpoonright \{x, y, \checkmark\} \in traces(Q) \wedge \sigma(tr) \subseteq \{a, b, x, y, \checkmark\}\} \quad \text{Alph. Parallel, 6.18-20} \\
&= \{tr \in TRACES \mid tr \upharpoonright \{a, b, \checkmark\} \in \{\langle \rangle, \langle a \rangle, \langle a, b \rangle, \langle a, b, \checkmark \rangle, \langle b \rangle, \langle b, d \rangle\} \wedge \\
&\quad tr \upharpoonright \{x, y, \checkmark\} \in \{\langle \rangle, \langle x \rangle, \langle x, \checkmark \rangle, \langle y \rangle, \langle x, y \rangle\} \wedge \\
&\quad \sigma(tr) \subseteq \{a, b, x, y, \checkmark\}\} \\
&= \{\langle \rangle, \langle a \rangle, \langle a, b \rangle, \langle a, b, \checkmark \rangle, \langle b \rangle, \langle b, d \rangle, \langle x \rangle, \langle x, \checkmark \rangle, \langle y \rangle, \langle x, y \rangle\} \\
&= \{\langle \rangle, \\
&\quad \langle a \rangle, \langle b \rangle, \langle a, b \rangle, \langle b, d \rangle, \\
&\quad \langle x \rangle, \langle y \rangle, \langle x, y \rangle, \\
&\quad \langle a, x \rangle, \langle x, a \rangle, \langle b, x \rangle, \langle x, b \rangle, \\
&\quad \langle a, b, x \rangle, \langle a, x, b \rangle, \langle x, a, b \rangle, \\
&\quad \langle b, d, x \rangle, \langle b, x, d \rangle, \langle x, b, d \rangle, \\
&\quad \langle a, y \rangle, \langle y, a \rangle, \langle b, y \rangle, \langle y, b \rangle, \\
&\quad \langle a, b, y \rangle, \langle a, y, b \rangle, \langle y, a, b \rangle, \\
&\quad \langle b, d, y \rangle, \langle b, y, d \rangle, \langle y, b, d \rangle, \\
&\quad \langle a, x, y \rangle, \langle x, a, y \rangle, \langle x, y, a \rangle, \\
&\quad \langle b, x, y \rangle, \langle x, b, y \rangle, \langle x, y, b \rangle, \\
&\quad \langle a, b, x, y \rangle, \langle a, x, b, y \rangle, \langle a, x, y, b \rangle, \langle x, a, y, b \rangle, \langle x, y, a, b \rangle, \langle x, a, b, y \rangle, \\
&\quad \langle b, d, x, y \rangle, \langle b, x, d, y \rangle, \langle x, b, d, y \rangle, \langle x, b, y, d \rangle, \langle x, y, b, d \rangle, \langle b, x, y, d \rangle, \\
&\quad \langle a, b, x, \checkmark \rangle, \langle a, x, b, \checkmark \rangle, \langle x, a, b, \checkmark \rangle\}
\end{aligned}$$