

FOOSE SoSe 2010 - Lösungsvorschlag zu Blatt 4

2. Juni 2010

1 Aufgabe 1

1. $\llbracket \text{self.employees} \rightarrow \text{includes}(p) \rrbracket_{\beta, \sigma^-, \sigma}$

$$\begin{aligned} &\stackrel{2.7.2a}{=} \llbracket _ \rightarrow \text{includes}(_) \rrbracket(\llbracket \text{self.employees} \rrbracket_{\beta, \sigma^-, \sigma}, \llbracket p \rrbracket_{\beta, \sigma^-, \sigma}) \\ &\stackrel{2.7.2c}{=} \llbracket _ \rightarrow \text{includes}(_) \rrbracket(\llbracket \text{self} \rrbracket_{\beta, \sigma^-, \sigma} \cdot \text{employees}_\sigma, \llbracket p \rrbracket_{\beta, \sigma^-, \sigma}) \\ &\stackrel{2.7.1}{=} \llbracket _ \rightarrow \text{includes}(_) \rrbracket(\beta(\text{self}).\text{employees}_\sigma, \beta(p)) \\ &= \llbracket _ \rightarrow \text{includes}(_) \rrbracket(\text{lufthansa.employees}_\sigma, \text{meier}) \\ &= \llbracket _ \rightarrow \text{includes}(_) \rrbracket(\{\text{meier}, \text{schmidt}, \text{mueller}\}, \text{meier}) \\ &\stackrel{2.5.4}{=} \text{true} \end{aligned}$$

2. $\llbracket \text{self.salary} = \text{self.salary@pre} + s \rrbracket_{\beta, \sigma^-, \sigma}$

$$\begin{aligned} &\stackrel{2.7.2a}{=} \llbracket _ = _ \rrbracket(\llbracket \text{self.salary} \rrbracket_{\beta, \sigma^-, \sigma}, \llbracket \text{self.salary@pre} + s \rrbracket_{\beta, \sigma^-, \sigma}) \\ &\stackrel{2.7.2a}{=} \llbracket _ = _ \rrbracket(\llbracket \text{self.salary} \rrbracket_{\beta, \sigma^-, \sigma}, \llbracket _ + _ \rrbracket(\llbracket \text{self.salary@pre} \rrbracket_{\beta, \sigma^-, \sigma}, \llbracket s \rrbracket_{\beta, \sigma^-, \sigma})) \\ &\stackrel{2.7.2c}{=} \llbracket _ = _ \rrbracket(\llbracket \text{self} \rrbracket_{\beta, \sigma^-, \sigma} \cdot \text{salary}_\sigma, \llbracket _ + _ \rrbracket(\llbracket \text{self.salary@pre} \rrbracket_{\beta, \sigma^-, \sigma}, \llbracket s \rrbracket_{\beta, \sigma^-, \sigma})) \\ &\stackrel{2.7.7}{=} \llbracket _ = _ \rrbracket(\llbracket \text{self} \rrbracket_{\beta, \sigma^-, \sigma} \cdot \text{salary}_\sigma, \llbracket _ + _ \rrbracket(\llbracket \text{self} \rrbracket_{\beta, \sigma^-, \sigma} \cdot \text{salary}_{\sigma^-}, \llbracket s \rrbracket_{\beta, \sigma^-, \sigma})) \\ &\stackrel{2.7.1}{=} \llbracket _ = _ \rrbracket(\beta(\text{self}).\text{salary}_\sigma, \llbracket _ + _ \rrbracket(\beta(\text{self}).\text{salary}_{\sigma^-}, \beta(s))) \\ &= \llbracket _ = _ \rrbracket(\text{schmidt.salary}_\sigma, \llbracket _ + _ \rrbracket(\text{schmidt.salary}_{\sigma^-}, 120)) \\ &= \llbracket _ = _ \rrbracket(1820, \llbracket _ + _ \rrbracket(1700, 120)) \\ &\stackrel{2.5.2}{=} \llbracket _ = _ \rrbracket(1820, 1700 + 120)) \\ &= \llbracket _ = _ \rrbracket(1820, 1820) \\ &\stackrel{2.5.1}{=} \text{true} \end{aligned}$$

3. $\llbracket \text{self.employees} \rightarrow \text{iterate}(p : \text{Person}; a : \text{Real} = 0 \mid a + p.\text{salary}) \rrbracket_{\beta, \sigma^-, \sigma}$

$$\begin{aligned}
&\stackrel{2.7.4}{=} it_{a + p.\text{salary}, \beta, \sigma^-, \sigma}(\llbracket \text{self.employees} \rrbracket_{\beta, \sigma^-, \sigma}, \llbracket 0 \rrbracket_{\beta, \sigma^-, \sigma}) \\
&\stackrel{2.7.2c}{=} it_{a + p.\text{salary}, \beta, \sigma^-, \sigma}(\llbracket \text{self} \rrbracket_{\beta, \sigma^-, \sigma}.\text{employees}_\sigma, 0) \\
&\stackrel{2.7.1}{=} it_{a + p.\text{salary}, \beta, \sigma^-, \sigma}(\beta(\text{self}).\text{employees}_\sigma, 0) \\
&= it_{a + p.\text{salary}, \beta, \sigma^-, \sigma}(\text{lufthansa.employees}_\sigma, 0) \\
&= it_{a + p.\text{salary}, \beta, \sigma^-, \sigma}(\{\text{meier}, \text{schmidt}, \text{mueller}\}, 0) \\
&\stackrel{2.7.4}{=} it_{a + p.\text{salary}, \beta, \sigma^-, \sigma}(\{\text{meier}, \text{schmidt}, \text{mueller}\} \setminus \{\text{meier}\}, \llbracket a + p.\text{salary} \rrbracket_{\beta_2 = \beta[p \mapsto \text{meier}, a \mapsto 0], \sigma^-, \sigma}) \\
&\stackrel{2.7.2a}{=} it_{a + p.\text{salary}, \beta, \sigma^-, \sigma}(\{\text{schmidt}, \text{mueller}\}, \llbracket _+ _ \rrbracket(\llbracket a \rrbracket_{\beta_2, \sigma^-, \sigma}, \llbracket p.\text{salary} \rrbracket_{\beta_2, \sigma^-, \sigma})) \\
&\stackrel{2.7.2c}{=} it_{a + p.\text{salary}, \beta, \sigma^-, \sigma}(\{\text{schmidt}, \text{mueller}\}, \llbracket _+ _ \rrbracket(\llbracket a \rrbracket_{\beta_2, \sigma^-, \sigma}, \llbracket p \rrbracket_{\beta_2, \sigma^-, \sigma}.\text{salary}_\sigma)) \\
&\stackrel{2.7.1}{=} it_{a + p.\text{salary}, \beta, \sigma^-, \sigma}(\{\text{schmidt}, \text{mueller}\}, \llbracket _+ _ \rrbracket(\beta_2(a), \beta_2(p).\text{salary}_\sigma)) \\
&= it_{a + p.\text{salary}, \beta, \sigma^-, \sigma}(\{\text{schmidt}, \text{mueller}\}, \llbracket _+ _ \rrbracket(0, \text{meier}.\text{salary}_\sigma)) \\
&= it_{a + p.\text{salary}, \beta, \sigma^-, \sigma}(\{\text{schmidt}, \text{mueller}\}, \llbracket _+ _ \rrbracket(0, 12000)) \\
&\stackrel{2.5.2}{=} it_{a + p.\text{salary}, \beta, \sigma^-, \sigma}(\{\text{schmidt}, \text{mueller}\}, 12000) \\
&\stackrel{2.7.4}{=} it_{a + p.\text{salary}, \beta, \sigma^-, \sigma}(\{\text{schmidt}, \text{mueller}\} \setminus \{\text{schmidt}\}, \llbracket a + p.\text{salary} \rrbracket_{\beta_3 = \beta[p \mapsto \text{schmidt}, a \mapsto 12000], \sigma^-, \sigma}) \\
&\stackrel{2.7.2a}{=} it_{a + p.\text{salary}, \beta, \sigma^-, \sigma}(\{\text{mueller}\}, \llbracket _+ _ \rrbracket(\llbracket a \rrbracket_{\beta_3, \sigma^-, \sigma}, \llbracket p.\text{salary} \rrbracket_{\beta_3, \sigma^-, \sigma})) \\
&\stackrel{2.7.2c}{=} it_{a + p.\text{salary}, \beta, \sigma^-, \sigma}(\{\text{mueller}\}, \llbracket _+ _ \rrbracket(\llbracket a \rrbracket_{\beta_3, \sigma^-, \sigma}, \llbracket p \rrbracket_{\beta_3, \sigma^-, \sigma}.\text{salary}_\sigma)) \\
&\stackrel{2.7.1}{=} it_{a + p.\text{salary}, \beta, \sigma^-, \sigma}(\{\text{mueller}\}, \llbracket _+ _ \rrbracket(\beta_3(a), \beta_3(p).\text{salary}_\sigma)) \\
&= it_{a + p.\text{salary}, \beta, \sigma^-, \sigma}(\{\text{mueller}\}, \llbracket _+ _ \rrbracket(12000, \text{schmidt}.\text{salary}_\sigma)) \\
&= it_{a + p.\text{salary}, \beta, \sigma^-, \sigma}(\{\text{mueller}\}, \llbracket _+ _ \rrbracket(12000, 1820)) \\
&\stackrel{2.5.2}{=} it_{a + p.\text{salary}, \beta, \sigma^-, \sigma}(\{\text{mueller}\}, 13820) \\
&\stackrel{2.7.4}{=} it_{a + p.\text{salary}, \beta, \sigma^-, \sigma}(\{\text{mueller}\} \setminus \{\text{mueller}\}, \llbracket a + p.\text{salary} \rrbracket_{\beta_4 = \beta[p \mapsto \text{mueller}, a \mapsto 13820], \sigma^-, \sigma}) \\
&\stackrel{2.7.2a}{=} it_{a + p.\text{salary}, \beta, \sigma^-, \sigma}(\emptyset, \llbracket _+ _ \rrbracket(\llbracket a \rrbracket_{\beta_4, \sigma^-, \sigma}, \llbracket p.\text{salary} \rrbracket_{\beta_4, \sigma^-, \sigma})) \\
&\stackrel{2.7.2c}{=} it_{a + p.\text{salary}, \beta, \sigma^-, \sigma}(\emptyset, \llbracket _+ _ \rrbracket(\llbracket a \rrbracket_{\beta_4, \sigma^-, \sigma}, \llbracket p \rrbracket_{\beta_4, \sigma^-, \sigma}.\text{salary}_\sigma)) \\
&\stackrel{2.7.1}{=} it_{a + p.\text{salary}, \beta, \sigma^-, \sigma}(\emptyset, \llbracket _+ _ \rrbracket(\beta_4(a), \beta_4(p).\text{salary}_\sigma)) \\
&= it_{a + p.\text{salary}, \beta, \sigma^-, \sigma}(\emptyset, \llbracket _+ _ \rrbracket(13820, \text{mueller}.\text{salary}_\sigma)) \\
&= it_{a + p.\text{salary}, \beta, \sigma^-, \sigma}(\emptyset, \llbracket _+ _ \rrbracket(13820, 1700)) \\
&\stackrel{2.5.2}{=} it_{a + p.\text{salary}, \beta, \sigma^-, \sigma}(\emptyset, 15520) \\
&\stackrel{2.7.4}{=} 15520
\end{aligned}$$

4. $\llbracket \text{self.employees} \rightarrow \text{iterate}(p : \text{Person}; a : \text{Real} = 0 \mid a + p.\text{salary}) \rrbracket_{\beta, \sigma, \sigma^-}$

Lösung genau wie oben, jedoch wird zur Auswertung der Zustand σ^- verwendet. Das Ergebnis lautet also $12000 + 1700 + 1700 = 15400$.

5. $\llbracket \text{Airline.allInstances@pre()} \rightarrow \text{exists}(a : \text{Airline} \mid a.\text{name@pre} = n) \rrbracket_{\beta, \sigma^-, \sigma}$

$\stackrel{2.7.5}{=} \llbracket \text{Airline.allInstances@pre()} \rightarrow \text{iterate}(a : \text{Airline} ; \text{res} : \text{Boolean} = \text{false} \mid \text{res or } (a.\text{name@pre} = n)) \rrbracket_{\beta, \sigma^-, \sigma}$
 $\stackrel{2.7.4}{=} it_{\text{res or } (a.\text{name@pre} = n), \beta, \sigma^-, \sigma}(\llbracket \text{Airline.allInstances@pre()} \rrbracket_{\beta, \sigma^-, \sigma}, \llbracket \text{false} \rrbracket_{\beta, \sigma^-, \sigma})$
 $\stackrel{2.7.6}{=} it_{\text{res or } (a.\text{name@pre} = n), \beta, \sigma^-, \sigma}(\{\text{lufthansa}\}, \text{false})$
 $\stackrel{2.7.4}{=} it_{\text{res or } (a.\text{name@pre} = n), \beta, \sigma^-, \sigma}(\emptyset, \llbracket \text{res or } (a.\text{name@pre} = n) \rrbracket_{\beta_2 = \beta[a \rightarrow \text{lufthansa}, \text{res} \rightarrow \text{false}], \sigma^-, \sigma})$
 $\stackrel{2.7.2a}{=} it_{\text{res or } (a.\text{name@pre} = n), \beta, \sigma^-, \sigma}(\emptyset, \llbracket _ \text{or} _ \rrbracket(\llbracket \text{res} \rrbracket_{\beta_2, \sigma^-, \sigma}, \llbracket a.\text{name@pre} = n \rrbracket_{\beta_2, \sigma^-, \sigma}))$
 $\stackrel{2.7.1, 2.7.2a}{=} it_{\text{res or } (a.\text{name@pre} = n), \beta, \sigma^-, \sigma}(\emptyset, \llbracket _ \text{or} _ \rrbracket(\beta_2(\text{res}), \llbracket _ = _ \rrbracket(\llbracket a.\text{name@pre} \rrbracket_{\beta_2, \sigma^-, \sigma}, \llbracket n \rrbracket_{\beta_2, \sigma^-, \sigma})))$
 $\stackrel{2.7.1, 2.7.7}{=} it_{\text{res or } (a.\text{name@pre} = n), \beta, \sigma^-, \sigma}(\emptyset, \llbracket _ \text{or} _ \rrbracket(\text{false}, \llbracket _ = _ \rrbracket(\llbracket a \rrbracket_{\beta_2, \sigma^-, \sigma}.\text{name}_{\sigma^-}, \beta_2(n))))$
 $\stackrel{2.7.1}{=} it_{\text{res or } (a.\text{name@pre} = n), \beta, \sigma^-, \sigma}(\emptyset, \llbracket _ \text{or} _ \rrbracket(\text{false}, \llbracket _ = _ \rrbracket(\beta_2(a).\text{name}_{\sigma^-}, \text{'Finnair'})))$
 $= it_{\text{res or } (a.\text{name@pre} = n), \beta, \sigma^-, \sigma}(\emptyset, \llbracket _ \text{or} _ \rrbracket(\text{false}, \llbracket _ = _ \rrbracket(\text{lufthansa}.\text{name}_{\sigma^-}, \text{'Finnair'})))$
 $= it_{\text{res or } (a.\text{name@pre} = n), \beta, \sigma^-, \sigma}(\emptyset, \llbracket _ \text{or} _ \rrbracket(\text{false}, \llbracket _ = _ \rrbracket(\text{'Lufthansa'}, \text{'Finnair'})))$
 $\stackrel{2.5.1}{=} it_{\text{res or } (a.\text{name@pre} = n), \beta, \sigma^-, \sigma}(\emptyset, \llbracket _ \text{or} _ \rrbracket(\text{false}, \text{false}))$
 $\stackrel{2.5.1}{=} it_{\text{res or } (a.\text{name@pre} = n), \beta, \sigma^-, \sigma}(\emptyset, \text{false})$
 $\stackrel{2.7.4}{=} \text{false}$

6. $\llbracket \text{result} = \text{Airline.allInstances()} \rightarrow \text{exists}(a : \text{Airline} \mid a.\text{oclIsNew}() \text{ and } a.\text{name} = n) \rrbracket_{\beta, \sigma^-, \sigma}$

$\stackrel{2.7.2a, 2.7.5}{=} \llbracket _ = _ \rrbracket(\llbracket \text{result} \rrbracket_{\beta, \sigma^-, \sigma}, \llbracket \text{Airline.allInstances()} \rightarrow \text{iterate}(a : \text{Airline}; \text{res} = \text{false} \mid \text{res or } (a.\text{oclIsNew}() \text{ and } a.\text{name} = n)) \rrbracket_{\beta, \sigma^-, \sigma})$
 $\stackrel{2.7.1, 2.7.4}{=} \llbracket _ = _ \rrbracket(\beta(\text{result}), it_{\text{res or } (a.\text{oclIsNew}() \text{ and } a.\text{name} = n), \beta, \sigma^-, \sigma}(\llbracket \text{Airline.allInstances()} \rrbracket_{\beta, \sigma^-, \sigma}, \llbracket \text{false} \rrbracket_{\beta, \sigma^-, \sigma}))$
 $\stackrel{2.7.2b}{=} \llbracket _ = _ \rrbracket(\text{true}, it_{\text{res or } (a.\text{oclIsNew}() \text{ and } a.\text{name} = n), \beta, \sigma^-, \sigma}(\{\text{finnair}, \text{lufthansa}\}, \text{false}))$
 $\stackrel{2.7.4}{=} \llbracket _ = _ \rrbracket(\text{true}, it_{\text{res or } (a.\text{oclIsNew}() \text{ and } a.\text{name} = n), \beta, \sigma^-, \sigma}(\{\text{lufthansa}\}, \llbracket \text{res or } (a.\text{oclIsNew}() \text{ and } a.\text{name} = n) \rrbracket_{\beta[a \rightarrow \text{finnair}, \text{res} \rightarrow \text{false}], \sigma^-, \sigma}))$
 $\stackrel{\dots}{=} \llbracket _ = _ \rrbracket(\text{true}, it_{\text{res or } (a.\text{oclIsNew}() \text{ and } a.\text{name} = n), \beta, \sigma^-, \sigma}(\{\text{lufthansa}\}, \text{false or } (\text{true and 'Finnair'} = \text{'Finnair'})))$
 $= \llbracket _ = _ \rrbracket(\text{true}, it_{\text{res or } (a.\text{oclIsNew}() \text{ and } a.\text{name} = n), \beta, \sigma^-, \sigma}(\{\text{lufthansa}\}, \text{true}))$
 $\stackrel{2.7.4}{=} \llbracket _ = _ \rrbracket(\text{true}, it_{\text{res or } (a.\text{oclIsNew}() \text{ and } a.\text{name} = n), \beta, \sigma^-, \sigma}(\emptyset, \llbracket \text{res or } (a.\text{oclIsNew}() \text{ and } a.\text{name} = n) \rrbracket_{\beta[a \rightarrow \text{lufthansa}, \text{res} \rightarrow \text{true}], \sigma^-, \sigma}))$
 $\stackrel{\dots}{=} \llbracket _ = _ \rrbracket(\text{true}, it_{\text{res or } (a.\text{oclIsNew}() \text{ and } a.\text{name} = n), \beta, \sigma^-, \sigma}(\emptyset, \text{true or } (\text{false and 'Lufthansa'} = \text{'Finnair'})))$
 $\stackrel{\dots}{=} \llbracket _ = _ \rrbracket(\text{true}, it_{\text{res or } (a.\text{oclIsNew}() \text{ and } a.\text{name} = n), \beta, \sigma^-, \sigma}(\emptyset, \text{true}))$
 $\stackrel{2.7.4}{=} \llbracket _ = _ \rrbracket(\text{true}, \text{true})$
 $= \text{true}$

7. $\llbracket \text{self.flights} \rightarrow \text{select}(f : \text{Flight} \mid f.\text{basicPrice} < 200) \rrbracket_{\beta, \sigma^-, \sigma}$

$\stackrel{2.7.5}{=} \llbracket \text{self.flights} \rightarrow \text{iterate}(f : \text{Flight}; \text{res} : \text{Set}(T) = \text{Set}\{\} \mid$
 $\quad \text{if } f.\text{basicPrice} < 200 \text{ then } \text{res} \rightarrow \text{including}(f) \text{ else } \text{res} \text{ endif}) \rrbracket_{\beta, \sigma^-, \sigma}$

$\stackrel{2.7.4}{=} it_{\text{if } f.\text{basicPrice} < 200 \text{ then } \text{res} \rightarrow \text{including}(f) \text{ else } \text{res} \text{ endif}, \beta, \sigma^-, \sigma}(\llbracket \text{self.flights} \rrbracket_{\beta, \sigma^-, \sigma}, \llbracket \text{Set}\{\} \rrbracket_{\beta, \sigma^-, \sigma})$

$\stackrel{\dots}{=} it_{\text{if } f.\text{basicPrice} < 200 \text{ then } \text{res} \rightarrow \text{including}(f) \text{ else } \text{res} \text{ endif}, \beta, \sigma^-, \sigma}(\{\#321\}, \text{Set}\{\})$

$\stackrel{2.7.4}{=} it_{\text{if } f.\text{basicPrice} < 200 \text{ then } \text{res} \rightarrow \text{including}(f) \text{ else } \text{res} \text{ endif}, \beta, \sigma^-, \sigma}(\emptyset,$
 $\quad \llbracket \text{if } f.\text{basicPrice} < 200 \text{ then } \text{res} \rightarrow \text{including}(f) \text{ else } \text{res} \text{ endif} \rrbracket_{\beta_2 = \beta[f \mapsto \#321, \text{res} \mapsto \text{Set}\{\}], \sigma^-, \sigma})$

$\stackrel{\dots}{=} it_{\text{if } f.\text{basicPrice} < 200 \text{ then } \text{res} \rightarrow \text{including}(f) \text{ else } \text{res} \text{ endif}, \beta, \sigma^-, \sigma}(\emptyset,$
 $\quad \llbracket \text{if } _ \text{ then } _ \text{ else } _ \text{ endif} \rrbracket(\llbracket f.\text{basicPrice} < 200 \rrbracket_{\beta_2, \sigma^-, \sigma}, \llbracket \text{res} \rightarrow \text{including}(f) \rrbracket_{\beta_2, \sigma^-, \sigma},$
 $\quad \llbracket \text{res} \rrbracket_{\beta_2, \sigma^-, \sigma}))$

$\stackrel{\dots}{=} it_{\text{if } f.\text{basicPrice} < 200 \text{ then } \text{res} \rightarrow \text{including}(f) \text{ else } \text{res} \text{ endif}, \beta, \sigma^-, \sigma}(\emptyset,$
 $\quad \llbracket \text{if } _ \text{ then } _ \text{ else } _ \text{ endif} \rrbracket(\llbracket 399 < 200 \rrbracket_{\beta_2, \sigma^-, \sigma}, \{\#321\}, \emptyset))$

$\stackrel{2.7.3}{=} it_{\text{if } f.\text{basicPrice} < 200 \text{ then } \text{res} \rightarrow \text{including}(f) \text{ else } \text{res} \text{ endif}, \beta, \sigma^-, \sigma}(\emptyset, \emptyset)$

$= \emptyset$