Text

Ex3

① $t \stackrel{\text{def}}{=} \text{rec } f \,.\, \lambda x.\ \text{if } \underbrace{\underbrace{\text{fst}(x)}_{②\,int} - \underbrace{\text{snd}(x)}_{③\,int}}_{①\,int} \text{ then } \underbrace{\text{snd}(x)}_{⑤\,int}$
$\text{else } f\ \underbrace{\left(\underbrace{\text{fst}(x) - \text{snd}(x)}_{⑥\,int},\ \underbrace{\text{snd}(x)}_{④\,int}\right)}_{⑦\,int*int}$

f : ⑬ $int*int \to int$, ⑨ $int*int \to int$, ⑧ $int*int \to int$, ⑩ int, ⑪ int, ⑫ $int*int \to int$, ⑭ $int*int \to int$

② $t\,(6,3) \to c \;\wedge\; t \to \lambda x.t' \quad t'\left[\frac{(6,3)}{x}\right] \to c$

$\nwarrow^{*}$ $t' = \text{if } \text{fst}(x) - \text{snd}(x) \text{ then } \text{snd}(x) \text{ else } t\,(\text{fst}(x) - \text{snd}(x), \text{snd}(x))$
$\quad \text{if } \text{fst}(6,3) - \text{snd}(6,3) \text{ then } \text{snd}(6,3) \text{ else } t\,(\text{fst}(6,3) - \text{snd}(6,3), \text{snd}(6,3)) \to c$

$\nwarrow \text{fst}(6,3) - \text{snd}(6,3) \to n \quad n \neq 0 \quad t\,(\text{fst}(6,3) - \text{snd}(6,3), \text{snd}(6,3)) \to c$

$\nwarrow_{n = n_1 - n_2} \text{fst}(6,3) \to n_1 \quad \text{snd}(6,3) \to n_2 \quad n_1 - n_2 \neq 0 \quad t\,(\text{fst}(6,3) - \text{snd}(6,3), \text{snd}(6,3)) \to c$

$\nwarrow^{*}_{n_1 = 6,\ n_2 = 3} \quad t\,\underbrace{(\text{fst}(6,3) - \text{snd}(6,3),\ \text{snd}(6,3))}_{e} \to c$

$\nwarrow \quad t \to \lambda x'.t'' \quad t''\left[\frac{e}{x}\right] \to c$

$\nwarrow^{*}_{x' = x,}$ $t'' = \text{if } \text{fst}(x) - \text{snd}(x) \text{ then } \text{snd}(x) \text{ else } t\,(\text{fst}(x) - \text{snd}(x), \text{snd}(x))$
$\quad \text{if } \text{fst}(e) - \text{snd}(e) \text{ then } \text{snd}(e) \text{ else } t\,(\text{fst}(e) - \text{snd}(e), \text{snd}(e)) \to c$

$\nwarrow \text{fst}(e) - \text{snd}(e) \to 0 \quad \text{snd}(e) \to c$

$\nwarrow_{n' = n_1' - n_2'} \text{fst}(e) \to n_1' \quad \text{snd}(e) \to n_2' \quad n_1' - n_2' = 0 \quad \text{snd}(e) \to c$

$\nwarrow \quad e \to (t_0, t_1) \quad t_0 \to n_1' \quad \text{snd}(e) \to n_2' \quad n_1' - n_2' = 0 \quad \text{snd}(e) \to c$

$\nwarrow_{t_0 = \text{fst}(6,3) - \text{snd}(6,3),\ t_1 = \text{snd}(6,3)} \quad \text{fst}(6,3) - \text{snd}(6,3) \to n_1' \quad \text{snd}(e) \to n_2' \quad n_1' - n_2' = 0 \quad \text{snd}(e) \to c$

$\nwarrow^{*}_{n_1' = 3} \quad \text{snd}(e) \to n_2' \quad 3 - n_2' = 0 \quad \text{snd}(e) \to c$

$\nwarrow \quad e \to (t_0', t_1') \quad t_1' \to n_2' \quad 3 - n_2' = 0 \quad \text{snd}(e) \to c$

$\nwarrow_{t_0' = \text{fst}(6,3) - \text{snd}(6,3),\ t_1' = \text{snd}(6,3)} \quad \text{snd}(6,3) \to n_2' \quad 3 - n_2' = 0 \quad \text{snd}(e) \to c$

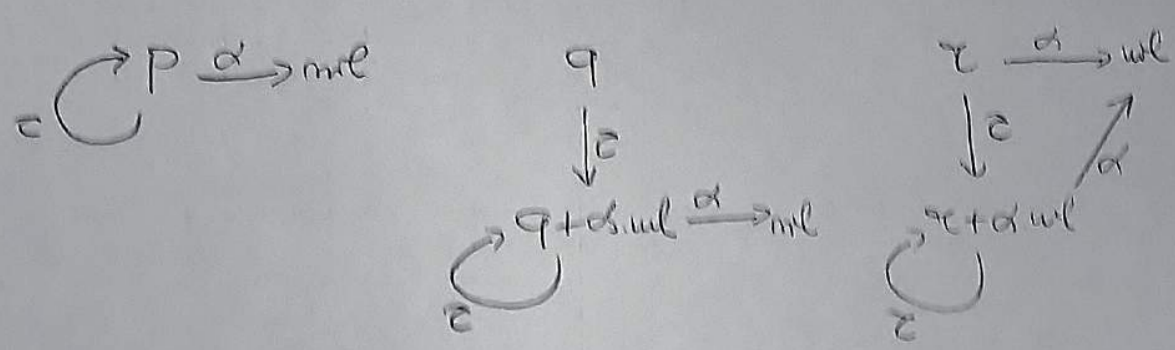
$\nwarrow^{*}_{n_2' = 3} \quad 3 - 3 = 0 \quad \text{snd}(e) \to c$

$\nwarrow^{*}_{c = 3} \quad \square$

Text

Es.5

Text

① 

② $p \not\simeq q$ $p \models \Diamond_\alpha true$ $q \not\models \Diamond_\alpha true$

$p \simeq r$ $R = \{\{p, r, r + \alpha.nil\}, \{nil\}\}$ is a bisimulation

③ $p \approx r$ because $p \simeq r$

$p \approx q$ $R = \{\{p, q, q + \alpha.nil\}, \{nil\}\}$ is a weak bisimulation