

Ed - long σ

Small-Step Semantics (Plotkin, 1980)

$\langle s, p \rangle \rightarrow \langle \underline{s}, p' \rangle$

$\underline{s} ::= \text{Cont} \langle . \rangle \mid \text{Out} \langle s \rangle \mid \text{Rec} \langle s \rangle \mid \dots$

continues
or finished

$(s_1; s_2); s_3$

$\langle \text{skip}, p \rangle \Downarrow p, \bullet$

$\langle x := e, p \rangle \Downarrow p[x \mapsto [e]_p], \bullet$

$\langle \text{skip}, p \rangle \rightarrow \langle \text{Out} \langle . \rangle, p \rangle$

$\langle x := e, p \rangle \rightarrow \langle \text{Cont} \langle s \rangle, p[x := [e]_p] \rangle$

$\frac{}{\langle s_1, p \rangle \Downarrow p, \sigma}$

$\frac{}{\langle s_1; s_2, p \rangle \Downarrow p, \sigma}$

$\frac{\langle s_1, p \rangle \rightarrow \langle \text{Out} \langle . \rangle, p' \rangle}{\langle s_1; s_2, p \rangle \rightarrow \langle \text{Cont} \langle s_2 \rangle, p' \rangle}$

$\frac{\langle s_1, p \rangle \Downarrow p, \bullet \quad \langle s_2, p \rangle \Downarrow p_2, \sigma}{\langle s_1; s_2, p \rangle \Downarrow p_2, \sigma}$

$\frac{\langle s_1, p \rangle \rightarrow \langle \text{Cont} \langle s'_1 \rangle, p' \rangle}{\langle s_1; s_2, p \rangle \rightarrow \langle \text{Out} \langle s'_1; s_2 \rangle, p' \rangle}$

$\frac{\langle s_1, p \rangle \rightarrow \langle \sigma, p' \rangle \quad \text{is Abort}(\sigma)}{\langle s_1; s_2, p \rangle \rightarrow \langle \sigma, p' \rangle}$

$\boxed{[e]_p = 0 \quad \langle s_2, \rho \rangle \Downarrow f_2, \sigma}$

$\langle \text{if}(e) \{ s_1 \} \text{else } \{ s_2 \}, \rho \rangle \Downarrow f_2, \sigma$

$\langle \text{if}(e) \{ s; \text{while}(e) \{ s \} \text{else } \{ \text{skip} \} \}, \rho \rangle \Downarrow \rho', \sigma$

$\langle \text{while}(e) \{ s \}, \rho \rangle \Downarrow \rho', \sigma$

$\boxed{[e]_p \neq 0}$

$\langle \text{if}(e) \{ s_1 \} \text{else } \{ s_2 \}, \rho \rangle \rightarrow \langle \text{out}(s_1), \rho \rangle$

$\langle \text{while}(e) \{ s \}, \rho \rangle \rightarrow \langle \text{out}(\langle \text{if}(e) \{ s; \text{while}(e) \{ s \} \text{else } \{ \text{skip} \} \rangle), \rho \rangle$

$$\boxed{x := f(e_1, \dots, e_n)}$$

$$\langle s, f, \boxed{\underline{CS}} \rangle$$

$$\langle x_1, \dots, x_n \rangle = \text{params}(f)$$

$$[e_i]_f = \sigma_i \Big|_{i=1}^n \quad f' = [x_i \mapsto \sigma_i]_{i=1}^n \quad \langle \text{body}(f), f' \rangle \Downarrow f'', \text{Ref} \sigma$$

$$\langle x := f(e_1, \dots, e_n), f' \rangle \Downarrow f'[x \mapsto \sigma], \cdot$$

$$\text{body}(f) = s_f \quad [e_i]_f = \sigma_i \Big|_{i=1}^n \quad \langle x_1, \dots, x_n \rangle = \text{params}(f)$$

$$f' = [x_i \mapsto \sigma_i]_{i=1}^n \quad CS' = (f, s, x) : CS$$

$$\langle \cancel{x} = f(e_1, \dots, e_n); \cancel{s}, \cancel{f'}, \cancel{CS} \rangle \rightarrow \langle \cancel{\text{Coat}} \cancel{\langle s_f \rangle}, f' \rangle$$

$$CS = [\text{store} \times \text{stmt} \times \text{Var}]$$

$\text{body}(f) = s_f \quad [e_i]_i = \sigma_i \Big|_{i=1}^n \quad \langle x_1, \dots, x_n \rangle = \text{params}(f)$

$\rho = [x_i \mapsto \sigma_i]_{i=1}^n \quad cs' = (f, s, x) : cs$

$\langle \underline{x} = f(e_1, \dots, e_n); \underline{s}, \underline{\rho}, \underline{cs} \rangle \rightarrow \langle \text{out} \langle s_f \rangle, \rho' \rangle$

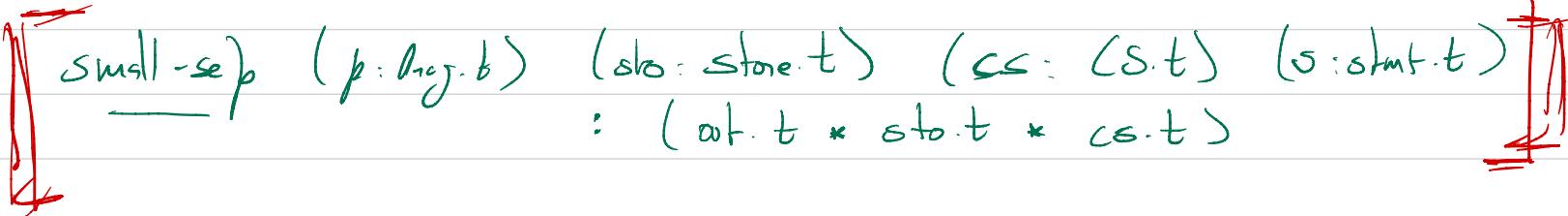
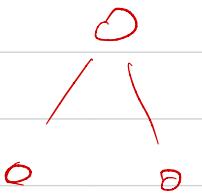
$cs = (f', s', x) : cs' \quad [c]_\rho = \sigma$

$\langle \text{return } c, \rho, cs \rangle \rightarrow \langle \text{out} \langle s' \rangle, \rho'[x \mapsto \sigma], cs' \rangle$

small-sep $(p: \text{obj_b}) \quad (\text{sto: store_t}) \quad (cs: (S, t)) \quad (s: \text{stmt_t})$
 $: (\text{obj_t} * \text{sto_t} * cs, t)$



small-step ($p: \text{Obj.-b}$) ($\text{sto}: \text{store.t}$) ($\text{cs}: (\text{s.t})$) ($s: \text{stmt.t}$)
 $\vdash (\text{at.t} * \text{sto.t} * \text{cs.t})$

multi-step ($p: \text{Obj.-b}$) ($\text{sto}: \text{store.t}$) ($\text{cs}: (\text{s.t})$) ($s: \text{stmt.t}$)
 $\vdash \text{at.t}$

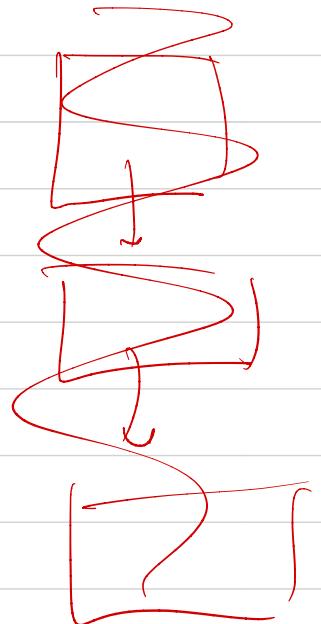
let $\sigma', \text{sto}', \text{cs}' = \text{small-step } p \text{ sto cs s}$
 match σ' with

$$\begin{bmatrix} - \\ - \\ - \end{bmatrix} \rightarrow \sigma'$$

case $\sigma' \rightarrow \text{multi-step } p \text{ sto}' \text{ cs}' \text{ s}'$

$\xrightarrow{\text{reduction e- code}}$

seq $\begin{bmatrix} \text{st_t} \\ - \end{bmatrix}$



interpret (p: Obj) (f: string) ✓ = ?

{
 sb =
 cs = []
 s =