

$v ::= x \mid \text{true} \mid \text{false} \mid \text{fun } x \mapsto c \mid \text{ND } \gamma_v$

$c ::= \text{if } v \text{ then } c_1 \text{ else } c_2 \mid v_1, v_2 \mid$

$\text{do } x \leftarrow c_1 \text{ in } c_2 \mid \text{return } v \mid \dots \mid \text{CD } \gamma_c$

$A ::= \text{bool} \mid A \rightarrow \underline{c}$

$\underline{c} ::= A \mid \Delta$

$c : \underline{c} \quad \gamma : \underline{c} \subseteq \underline{c}'$

$\gamma_v ::= \langle \text{bool} \rangle \mid \gamma_v \rightarrow \gamma_c$

$\text{CD } \gamma : \underline{c}'$

$\gamma_c ::= \gamma_v \mid \gamma_0$

$(\text{do } x \leftarrow c_1 \text{ in } c_2)^* = \begin{cases} \text{let } x = c_1^* \text{ in } c_2^* & \text{if } c_1 \text{ pwc} / c_1 : A \mid \emptyset \\ c_1^* \gg (\text{fun } x \rightarrow c_2^*) & \end{cases}$

$(A \mid \Delta)^* = \begin{cases} A^* & \\ A^* \text{ comp} & \end{cases} \quad \Delta = \emptyset$

$(\text{CD } \gamma)^* = c^* \mid \gamma^*$

$(\gamma_v \mid \gamma_0)^* = \begin{cases} \vdots \end{cases}$

Algo 2030

let applyZero f = f 0

applyZero cos

Ex Algo 2030

let applyZero _{α β} (f: $\alpha \rightarrow \beta$) = f (0Dw)
(w: int \leq α)

$\forall \alpha, \beta. (\text{int} \leq \alpha) \Rightarrow (\alpha \rightarrow \beta) \rightarrow \beta$

applyZero float float int2float cos

OCAML

let apply-zero w f = f (w 0)

(int \rightarrow 'a) \rightarrow ('a \rightarrow 'b) \rightarrow 'b

apply-zero int-to-float cos

let applyZero' _{β} (f: int \rightarrow β) = f 0

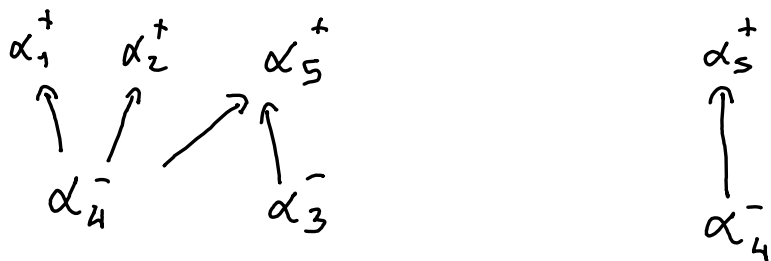
applyZero'_{float} (cosD (int2float \rightarrow (float))
" "
cos o int2float)

let applyIf p f x =

if p x then f x else x

$$(\alpha_1^+ \rightarrow \text{bool}) \rightarrow (\alpha_2^+ \rightarrow \alpha_3^-) \rightarrow \alpha_4^- \rightarrow \alpha_5^+$$

$$(\alpha_4^+ \rightarrow \text{bool}) \rightarrow (\alpha_4^+ \rightarrow \alpha_5^+) \rightarrow \alpha_4^+ \rightarrow \alpha_5^+$$



... applyIf A_1, A_2, A_3, A_4, A_5 r_1, r_2, r_3, r_4 ...

}
}

... (applyIf A'_1, A'_2, A'_3 r'_1, r'_2, r'_3).A.f ...

In general

$$\Gamma \vdash_{\equiv} v : A$$

$$\text{Simpl}(\equiv, \Gamma, A) = (\equiv', \sigma : \equiv \rightarrow \equiv')$$

$$\sigma(\Gamma) \vdash_{\equiv'} \sigma(v) : \sigma(A)$$

$$\forall \eta \Vdash \equiv. \exists \eta' \Vdash \equiv'.$$

$$\eta \geq \eta' \circ \sigma \quad \dots \quad \underset{\Vdash \Gamma}{\chi_A} : \underset{\geq}{\eta'(\sigma(A))} \leq \eta(A)$$

$$\llbracket \Gamma \vdash_{\equiv} v : A \rrbracket_{\eta} =$$

$$\llbracket \chi_A \rrbracket \circ \llbracket \sigma(\Gamma) \vdash_{\equiv'} \sigma(v) : \sigma(A) \rrbracket_{\eta'} \circ \llbracket \Gamma \rrbracket$$

← *comp irrelevant* →