

TD 2: } Interprétation avec effets de bord et Typage

let $x = \text{ref } 1$ in $((!x)) + (x := 2; (!x))$;

$\{x \mapsto 1\} \vdash (!x) \Rightarrow 1$ $\{x \mapsto 1\} \vdash (x := 2; (!x)) \Rightarrow 2$
 $\{x \mapsto 1\} \vdash (!x) \Rightarrow 1$ $\{x \mapsto 2\} \vdash (!x) \Rightarrow 2$

3

< Exercice 2.2 > Ajout des effets de bord

<1> $\text{Expr} \Rightarrow \text{ref Expr2}$ ex. let $x = \text{ref } 22$

$\gamma \vdash (e, m_1) \Downarrow (v, m_2) @ \text{add} \neq m_2$

$\gamma \vdash (\text{ref}, m_1) \Downarrow (@\text{add}, m_2 :: \{\text{add} \mapsto v\})$

memory

ref address \rightarrow 类似于指针, 指向地址

<2> $! \text{Expr}$ $(!e)$

$\gamma \vdash (e, m_1) \Downarrow (@\text{add}, m_2) \quad \text{add} \in m_2 \quad m_2(\text{add}) = v$

$\gamma \vdash (!e, m_1) \Downarrow (v, m_2)$

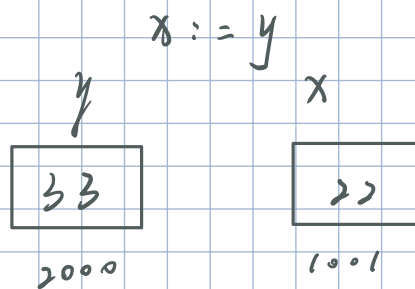
Problem: $e \not\Rightarrow @ \text{add}$

<3> $\text{Expr} ::= \text{Expr} \quad (x := e)$

① 读取 add 地址下的值

$\gamma \vdash (x, m_1) \Downarrow (@\text{add}, m_2) \quad \gamma \vdash (e, m_2) \Downarrow (v, m_3) @ \text{add} \in m_1$

$\gamma \vdash (x := e, m_1) \Downarrow (\underline{\quad}, m_3 :: \{@ \text{add} \mapsto v_3\})$
unit type



1. 在 y 的地址上读取 y 的值 "33"
2. 赋值

<4> $\text{Expr}; \text{Expr} (e_1; e_2)$

$\gamma \vdash (e_1, m_1) \Downarrow (v_1, m_2)$ $\gamma \vdash (e_2, m_2) \Downarrow (v_2, m_3)$

$\gamma \vdash (e_1; e_2, m_1) \Downarrow (v_2, m_3)$

$e_1; (e_2; (e_3))$

<5> $\text{while } e_1 \text{ do } e_2 \text{ done}$

$\gamma \vdash (e_1, m_1) \Downarrow (\text{true}, m_2)$ $\gamma \vdash (e_2, m_2) \Downarrow (v_2, m_3)$ $\gamma \vdash (\text{while } (e_1), m_2) \Downarrow (v_2, m_n)$

$\gamma \vdash (\text{while } e_1 \text{ do } e_2 \text{ done}, m_1) \Downarrow (v_2, m_n)$

↑ ↓
 boolean any type

$\gamma \vdash (e_1, m_1) \Downarrow (\text{false}, m_2)$

$\gamma \vdash (\text{while } e_1 \text{ do } e_2 \text{ done}, m_1) \Downarrow (v_2, m_n)$

... 接上行

Problem: $e_1 \not\Rightarrow \text{boolean}$

< Exercise 3 > Verification par Typage

<1> if e_1 then e_2 else e_3
 ↙ ↘ ↘
 boolean e_2, e_3 same type, τ

$$\frac{\sigma \vdash e_1 : \text{bool} \quad \sigma \vdash e_2 : \tau \quad \sigma \vdash e_3 : \tau}{\sigma \vdash \text{if } e_1 \text{ then } e_2 \text{ else } e_3 : \tau}$$

<2> let rec $x = e_1$ in e_2 types of e_1, e_2 are might be different
 自写的

$$\sigma :: \{x \mapsto \tau_1\} \vdash e_1 : \tau_1 \quad \sigma :: \{x \mapsto \tau_1\} \vdash e_2 : \tau_2 \quad \boxed{\sigma \vdash e_1 : \tau_1 \quad \sigma \vdash e_2 : \tau_2}$$

$$\sigma \vdash \text{let rec } \boxed{x = e_1} \text{ in } e_2 : \tau$$

也许是整体?

<3> $e_1 ; e_2$

$$\frac{\sigma \vdash e_1 : \text{unit} \quad \sigma \vdash e_2 : \tau}{\sigma \vdash e_1 ; e_2 : \tau}$$

$$\sigma \vdash e_1 ; e_2 : \tau$$

<4> while e_1 do e_2 done

$$\sigma \vdash e_1 : \text{bool} \quad \sigma \vdash e_2 : \text{unit}$$

$$\sigma \vdash \text{while } e_1 \text{ do } e_2 \text{ done} : \text{unit}$$

$$\sigma \vdash e_1 : @\tau \quad \sigma \vdash e_2 : \tau$$

$$\sigma \vdash e_1 := e_2 : \text{unit}$$

$$\sigma \vdash e : \tau$$

$$\sigma \vdash \text{ref } e : @\tau$$

$$\sigma \vdash e : @$$

$$\sigma \vdash !e : \tau$$