FR Type / Borrow Check

Recap

Types

$$T ::= \overbrace{\epsilon}^{\text{unit}} \mid \text{int} \mid \&[\text{mut}]\,\overbrace{u}^{\text{l-value}} \mid \Box T$$

$$\Box \dots \Box \ \text{int}$$

$$\Box \dots \Box \ \&[\text{mut}]\ t \dots \& x$$

Partial Types

$$\tilde{T} ::= T \mid \Box \tilde{T} \mid \overbrace{\lfloor T \rfloor}^{\text{undefined}}$$

$$\Box \dots \Box \lfloor T \rfloor \quad \text{or} \quad T$$

Def. 3.6.

$$\mathrm{copy}(T) = \begin{cases} \text{true} & T = \mathrm{int} \text{ or } T = \&w \\ \text{false} & \text{o/w.} \end{cases}$$

Def 3.7 – 3.10 IGNORE

Def 3.11

$$\frac{\Gamma(x) = \overbrace{\langle \tilde{T} \rangle^m}^{\text{slot}}}{\Gamma \vdash x : \langle \tilde{T} \rangle^m}\ (\text{var}) \qquad \frac{\Gamma \vdash w : \langle \square \tilde{T} \rangle^m}{\Gamma \vdash *w : \langle \tilde{T} \rangle^m}\ (\text{box})$$

$$\frac{\Gamma \vdash w : \langle \&[\mathrm{mut}]\, u \rangle^n \qquad \Gamma \vdash u : \langle T \rangle^m}{\Gamma \vdash *w : \langle T \rangle^m}$$

type, not partial, so no "undefineds"

is a type because, no moves behind references

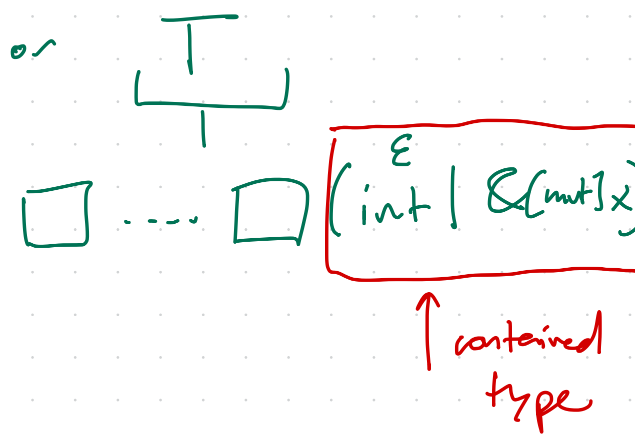
Def 3.12-13 A **path** π is seq. of "$*$"

"$****$"

Def 3.14 $w \bowtie v \iff$ $w = ***\ldots*\ x$, $v = ***\ldots*\ x$ — same variable

Def 3.15 (alternative)

$\tilde{T} = \square \ldots \square [T]$ or



The contained type of T is the int or &[mut] under all the boxes of T, if defined.

contained(T)

Def 3.16. readProhibited(Γ, w) =

$\exists x.$ s.t. $\Gamma(x) = \langle T \rangle^m$ and contained(T) = &mut r

and $w \bowtie r$

Def 3.17 writeProhibited(Γ, w) = readProhibited(Γ, w)

or $\exists x.$ s.t. $\Gamma(x) = \langle T \rangle^m$ and contained$(T) = \& r$

and $w \bowtie r$

must be a type (we have to check)

$$\frac{\Gamma \vdash w : \langle T \rangle^m \quad \text{copy}(T) \quad \neg\,\text{readProhibited}(\Gamma, w)}{\Gamma \vdash \langle \hat{w} : T \rangle^l \dashv \Gamma} \text{(copy}$$

$$\frac{}{\Gamma \vdash \langle c : \text{int} \rangle^{\ell} \dashv \Gamma}\ (\text{int}) \qquad \frac{}{\Gamma \vdash \langle \varepsilon : \varepsilon \rangle^{\ell} \dashv \Gamma}\ (\text{unit})$$

must be a type

$$\frac{\Gamma_1 \vdash w : \langle T \rangle^{m} \qquad \neg\,\text{writeProhibited}(\Gamma_1, w) \qquad \Gamma_2 = \text{move}(\Gamma_1, w)}{\Gamma_1 \vdash \langle w : T \rangle^{\ell} \dashv \Gamma_2}$$

example

$$\{x \mapsto \langle \square\,\square\ \text{int} \rangle^{m}\} \vdash \langle * x : \square\ \text{int} \rangle^{\ell} \dashv \{x \mapsto \langle \square[\square\ \text{int}] \rangle^{m}\}$$

$$\text{move}(\overbrace{\{x \mapsto \langle \square\,\square\ \text{int} \rangle^{m}\}}^{\Gamma}, * x) = \Gamma[x \mapsto \langle \tilde{T}_2 \rangle^{m}]$$

$$\tilde{T}_2 = \text{strike}(*, \square\,\square\ \text{int}) = \square[\square\ \text{int}]$$

Def 3.18

$$\text{move}(\Gamma, w) = \Gamma[x \mapsto \langle \tilde{T}_2 \rangle^{\ell}] \quad \underline{\text{where}}$$

$$w = \overbrace{* \dots *}^{\pi}\, x$$

$$\Gamma(x) = \tilde{T}_{\underline{1}}$$

$$\tilde{T}_2 = \text{strike}(\pi, \tilde{T}_1)$$

will be a type by above

$$\text{strike}(\varepsilon, T) = [T]$$

$$\text{strike}(*\pi', \square \tilde{T}) = \square \tilde{T}' \quad \text{where } \tilde{T}' = \text{strike}(\pi, \tilde{T})$$

$$\text{strike}(**, \square\square\square\, \text{int}) = \square\, \text{strike}(*, \square\square\, \text{int})$$

$$= \square\square\, \text{strike}(\varepsilon, \square\, \text{int})$$

$$= \square\square\, [\square\, \text{int}]$$

$$\frac{\Gamma \vdash w : \langle \overset{\text{must be a type}}{T} \rangle^{m} \qquad \neg\, \mathrm{readProhibited}(\Gamma, w)}{\Gamma \vdash \langle \&w : \&w \rangle^{\ell} \dashv \Gamma} \ (\text{imm. bor.})$$

$$\frac{\Gamma \vdash w : \langle T \rangle^{m} \qquad \neg\, \mathrm{writeProhibited}(\Gamma, w) \qquad \mathrm{mut}(\Gamma, w)}{\Gamma \vdash \langle \&\mathrm{mut}\ w : \&\mathrm{mut}\ w \rangle^{\ell} \dashv \Gamma}$$

Def 3.19

$\mathrm{mut}(\Gamma, w) = \mathrm{mutable}(\Gamma, \pi, \hat{T})$ where

$$w = \underbrace{* \ldots *}_{\pi} x$$

$$\Gamma(x) = \langle \hat{T} \rangle^{m}$$

$$\text{mutable}(\Gamma, \varepsilon, T) = \text{true}$$

$$\text{mutable}(\Gamma, *\pi', \square T) = \text{mutable}(\Gamma, \pi', T)$$

$$\text{mutable}(\Gamma, *\pi', \&\text{mut } v) = \text{mut}(\Gamma, \pi' v)$$

$$\text{mutable}(\_) = \text{false}$$

$$\Gamma$$

$$\{ v \mapsto \langle \& x \rangle^m, \ x \mapsto \langle \text{int} \rangle^m \} \nvdash \&\text{mut } *v$$

$$\text{mut}(\Gamma, *v) = \text{mutable}(\Gamma, *, \& x) = \text{false}$$

$$\{ v \mapsto \langle \&\text{mut } x \rangle^m, \ x \mapsto \langle \text{int} \rangle^m \} \vdash \langle \&\text{mut } *v \rangle^\ell \dashv \Gamma$$

$$\text{mut}(\Gamma, *v) = \text{mutable}(\Gamma, *, \&\text{mut } x)$$

$$= \text{mut}(\Gamma, x)$$

$$= \text{mutable}(\Gamma, \varepsilon, \text{int}) = \text{true} \quad ✓$$

Def 3.20 (drop)

$$\mathrm{drop}(\Gamma, m) = \underbrace{\Gamma \setminus \{ x \mapsto \langle r \rangle^m : x \mapsto \langle r \rangle^m \in \Gamma \}}_{\text{remove types with lifetime } m}$$

$\&\mathrm{mut} \; \cancel{*}\cancel{*} x$

$\{ x \mapsto \langle \&\mathrm{mut}\ y \rangle^m, \; y \mapsto \langle \& z \rangle^m, \; z \mapsto \langle \mathrm{int} \rangle^m \}$