Progress

Assume:

(1) $\vdash H : *$

(2) $H \vdash \overline{TS}$?

(3) $\forall (f, FS) \in TS.$ $H; a \vdash FS$ ok

Show:

(I) $H, \overline{TS} \rightsquigarrow H', \overline{US}$

(II) $\vee\ TS = \emptyset$

(III) $\vee\ FS = F \circ FS'$ where something null

Case distinction on TS:

- $\emptyset$: Done by (II)
- $T \uplus TS'$: Obtain Task $T = (f, k, FS)$ by Reducable taskset $\begin{pmatrix} FS = \varepsilon \\ \vee\ FS = F \circ FS' \wedge (F \neq \langle \text{FINISH } f \rangle' \\ \vee\ F = \langle \text{FINISH } f \rangle' \wedge \nexists (f, \_, \_) \in TS) \end{pmatrix}$

  Case distinction on FS:

  - ε: $H, T \uplus TS' \rightsquigarrow H, TS'$ by E-TASK-DONE
  - $\langle \text{FINISH } f' \rangle' \circ FS'$: $H, \{(f, k, \langle \text{FINISH } f' \rangle' \circ FS')\} \uplus TS \rightsquigarrow H, \{(f, k, FS')\} \uplus TS$ by E-FINISH2, ReducableTaskset
  - $\langle L, u, P \rangle' \circ FS'$:

    Induction on u:

    See following pages

$F = \langle L,\ \text{async}(b, x \Rightarrow t)\{u\},\ \{p\} \uplus P \rangle^{l}$

Show: (IV) $L(b) \models b(0,p)$

(5) $H \vdash F : \sigma$ by (2), T-FS-A, T-FS-NA
$H \vdash \Gamma ; L$ by prev, T-FRAME1
(7) $\forall x \in \text{dom}(\Gamma).\ H \vdash \Gamma ; L \ni x$

(6) $\Gamma ; a \vdash \text{async}(b, x \Rightarrow t)\{u\} : \tau$ by (5), T-FRAME1
(9) $\Gamma ; a \vdash b : Q \triangleright \text{Box}[C]$ by prev, T-ASYNC
(10) $b \in \text{dom}(\Gamma)$ by prev, T-VAR
(8) $H \vdash \Gamma ; L \ni b$ by prev, (7)

$L(b) = \text{null}$
$\vee\ L(b) = 0 \wedge \text{typeof}(H,0) <: \Gamma(b)$ $\not\Rightarrow$ false, typeof can never be Box[C]
$\vee\ L(b) = b(a,p) \wedge \Gamma(b) = Q \triangleright \text{Box}_X[C] \wedge \text{typeof}(H,a) <: C$ by prev, WF-VAR

$L(b) = \text{null} \vee L(b) = b(0,p)$ by (9), T-VAR, prev
($\Gamma(b) = \text{Box}[C]$)

Shows (III) or (IV)

(V) $p \in P$

$\forall \text{Perm}[Q] \in \Gamma.\ y(Q) \in P$ by WF-Perm, injective y

$\Gamma(b) = Q \triangleright \text{Box}[C] \wedge L(b) = b(0,p) \wedge \text{Perm}[Q] \in \Gamma \Rightarrow p \in P$ by WF-PERM, prev
($\Gamma(b) = Q \triangleright \text{Box}[C]$: (9), T-VAR; $L(b) = b(0,p)$: IV; $\text{Perm}[Q] \in \Gamma$: (6), T-ASYNC)

if eval gets stuck (III)
showing (V) doesn't matter

$F = \langle L, \text{let } x = \text{finish } \{t\} \text{ in } s, P \rangle^c$

Show: $\varnothing$

Preconditions of the other rules were not changed. As such, the proofs from LaCasa can be reused. Changes to E-Capture etc. only modify the new tasks.