termvar, x, y, d	Term-level variable			
$\ell abel$, ℓ	::=			Label
$hole$, h	::=			Hole
term_value, v	::=			Term value
	|	ℓ		Label representing an Ampar
	|	$@h$		Destination
	|	$()$		Unit
	|	$\mathsf{Inl}\ v$		Left variant for sum
	|	$\mathsf{Inr}\ v$		Right variant for sum
	|	(v_1, v_2)		Product
	|	$\lambda x.\ t$		Linear function
	|	(v)	S	
$\overline{\text{extended\_value}}$, $\overline{v}$	::=			Store value
	|	v		Term value
	|	h		Hole
	|	$\mathsf{Inl}\ \overline{v}$		Left variant with val or hole
	|	$\mathsf{Inr}\ \overline{v}$		Right variant with val or hole
	|	$(\overline{v_1}, \overline{v_2})$		Product with val or hole
	|	$(\overline{v})$	S	
term, t, u	::=			Term
	|	v		Term value
	|	x		Variable
	|	$t\ u$		Application
	|	$t \succ \mathbf{case}\ () \mapsto u$		Pattern-match on unit
	|	$t \succ \mathbf{case}\ \{\mathsf{Inl}\ x_1 \mapsto u_1, \mathsf{Inr}\ x_2 \mapsto u_2\}$		Pattern-match on sum
	|	$t \succ \mathbf{case}\ (x_1, x_2) \mapsto u$		Pattern-match on product
	|	$t \succ \mathbf{mapL}\ x \mapsto u$		Map over the left side of the ampar
	|	$\mathbf{to}_{\ltimes}\ t$		Wrap t into a trivial ampar
	|	$\mathbf{from}_{\ltimes}\ t$		Extract value from trivial ampar
	|	$\mathbf{alloc}$		Return a fresh "identity" ampar object
	|	$t \triangleleft ()$		Fill destination with unit
	|	$t \triangleleft \mathsf{Inl}$		Fill destination with left variant
	|	$t \triangleleft \mathsf{Inr}$		Fill destination with right variant
	|	$t \triangleleft (,)$		Fill destination with product constructor
	|	$t \triangleleft\!\bullet\ u$		Fill destination with root of ampar u
	|	(t)	S	
	|	$t[\mathrm{subs}]$	M	
$\overline{\text{extended\_term}}$, $\overline{t}$	::=			Extended term
	|	t		
	|	$\overline{v}$		
sub	::=			Variable or label substitution
	|	$x := v$		
	|	$h := \overline{v}$		
subs	::=			Substitutions
	|	sub		
	|	sub, subs		

store, S	::=		
	|	$[]$	
	|	$[\,$store_assigns$\,]$	
	|	S[subs]	
	|	$S_1 \sqcup S_2$	
store_assign, ha	::=		
	|	$\ell \mapsto \langle v_1 \,, \overline{v_2} \rangle$	Closed ampar ($\overline{v_2}$ = root of the incomplete struct)
	|	$\ell \mapsto \langle \blacksquare \,, \overline{v_2} \rangle$	Open ampar ($\overline{v_2}$ = root of the incomplete struct)
store_assigns	::=		
	|	ha	
	|	ha, store_assigns	
type, **A**, **B**	::=		Type
	|	$\mathbf{1}$	Unit
	|	$A_1 \oplus A_2$	Sum
	|	$A_1 \otimes A_2$	Product
	|	$A_1 \ltimes A_2$	Ampar type (consuming A_1 yields A_2)
	|	$A_1 \,{}_{m_1}\!\multimap A_2$	Linear function
	|	A^D	Destination
	|	(A)	S
mode, m	::=		Mode
	|	L	Local
	|	F	Foreign
	|	G	Global
	|	max_mode(Γ)	
	|	**if** mode_cond **then** m_3 **else** m_4	
mode_cond	::=		Mode statement
	|	$m_1 = m_2$	
	|	$m \in$ **upper_modes** (Γ)	
	|	$\exists m \in$ **upper_modes** (Γ)	
typing_context, $\mho$, Γ	::=		Typing context
	|	$\{\}$	
	|	{type_assigns}	
	|	$\Gamma_1 \sqcup \Gamma_2$	
	|	$\Gamma_1 \uplus \Gamma_2$	
	|	$\Gamma[m_1 \mapsto m_2]$	
	|	(Γ)	S
type_assign, ta	::=		Type assignment
	|	$x :_m A$	
	|	$+\ell : A$	
	|	$-\ell : A$	
	|	$+h : A$	Destination
	|	$-h : A$	Hole
type_assigns	::=		Type assignments
	|	ta	
	|	ta, type_assigns	

terminals	::=	
	|	$\multimap$
	|	$\rtimes$
	|	$\mapsto$
	|	$()$
	|	**Inl**
	|	**Inr**
	|	$(,)$
	|	$\triangleleft$
	|	$\triangleleft\!\bullet$
	|	$\sqcup$
	|	$\uplus$
	|	$\{\}$
	|	$\exists$
	|	$\neq$
	|	$\leq$
	|	$\in$
	|	$\notin$
	|	$\subset$
	|	$\mathcal{N}$
	|	$\vdash$
	|	$\mid$
	|	$\Downarrow$
formula	::=	
	|	judgement
Ctx	::=	
	|	$x \in \mathcal{N}(\Gamma)$
	|	$\ell \in \mathcal{N}(\Gamma)$
	|	$x \notin \mathcal{N}(\Gamma)$
	|	$\ell \notin \mathcal{N}(\Gamma)$
	|	**fresh** x
	|	**fresh** ℓ
	|	**fresh** h
	|	type_assign $\in \Gamma$
	|	**positive** (Γ)
	|	`mode_cond`
Eq	::=	
	|	$\mathbf{A}_1 = \mathbf{A}_2$
	|	$\mathbf{A}_1 \neq \mathbf{A}_2$
	|	$t = u$
	|	$t \neq u$
	|	$\Gamma_1 = \Gamma_2$
	|	$\mathcal{N}(\Gamma_1) \cap \mathcal{N}(\Gamma_2) = \emptyset$
Ty	::=	
	|	$\Gamma \vdash S \mid t : \mathbf{A}$
	|	$\Gamma \vdash S$
	|	$\Gamma \vdash \bar{t} : \mathbf{A}$
Sem	::=	

	|	$\mathsf{S} \mid \mathsf{t} \Downarrow \mathsf{S}' \mid \mathsf{t}'$
judgement	::=	
	|	Ctx
	|	Eq
	|	Ty
	|	Sem
user_syntax	::=	
	|	termvar
	|	*label*
	|	*hole*
	|	term_value
	|	extended_value
	|	term
	|	extended_term
	|	sub
	|	subs
	|	store
	|	store_assign
	|	store_assigns
	|	**type**
	|	mode
	|	mode_cond
	|	typing_context
	|	type_assign
	|	type_assigns
	|	terminals

$\boxed{\mathsf{x} \in \mathcal{N}(\Gamma)}$

$\boxed{\ell \in \mathcal{N}(\Gamma)}$

$\boxed{\mathsf{x} \notin \mathcal{N}(\Gamma)}$

$\boxed{\ell \notin \mathcal{N}(\Gamma)}$

$\boxed{\textbf{fresh}\ \mathsf{x}}$

$\boxed{\textbf{fresh}\ \ell}$

$\boxed{\textbf{fresh}\ h}$

$\boxed{\text{type\_assign} \in \Gamma}$

$\boxed{\textbf{positive}\ (\Gamma)}$

$\boxed{\texttt{mode\_cond}}$

$\boxed{\mathbf{A}_1 = \mathbf{A}_2}$

$\boxed{\mathbf{A}_1 \neq \mathbf{A}_2}$

$\boxed{\mathsf{t} = \mathsf{u}}$

$\boxed{\mathsf{t} \neq \mathsf{u}}$

$\boxed{\Gamma_1 = \Gamma_2}$

$\boxed{\mathcal{N}(\Gamma_1) \cap \mathcal{N}(\Gamma_2) = \emptyset}$

$\boxed{\Gamma \vdash \mathsf{S} \mid \mathsf{t} : \mathbf{A}}$

$$\frac{\begin{array}{c}\Gamma_1 \vdash \mathsf{S} \\ \Gamma_2 \vdash \mathsf{t} : \mathbf{A}\end{array}}{\Gamma_1 \uplus \Gamma_2 \vdash \mathsf{S} \mid \mathsf{t} : \mathbf{A}} \quad \textsc{TyCmd\_Cmd}$$

$\boxed{\Gamma \vdash S}$

$$\frac{}{\{\} \vdash []}\ \textsc{TyHeap\_Empty}$$

$$\frac{\Gamma_1 \vdash S_1 \quad \Gamma_2 \vdash S_2}{\Gamma_1 \uplus \Gamma_2 \vdash S_1 \sqcup S_2}\ \textsc{TyHeap\_Union}$$

$$\frac{\Gamma_1 \vdash v_1 : A_1 \quad \Gamma_2 \vdash \overline{v_2} : A_2 \quad \Gamma_3 = \Gamma_1 \uplus \Gamma_2 \quad \textsf{positive}\,(\Gamma_3)}{\Gamma_3 \sqcup \{-\underline{\ell} : A_1 \rtimes A_2\} \vdash [\,\underline{\ell} \mapsto \langle v_1 \,,\, \overline{v_2}\rangle\,]}\ \textsc{TyHeap\_ClosedAmpar}$$

$$\frac{\Gamma_2 \vdash \overline{v_2} : A_2}{\Gamma_2 \vdash [\,\underline{\ell} \mapsto \langle \blacksquare \,,\, \overline{v_2}\rangle\,]}\ \textsc{TyHeap\_OpenAmpar}$$

$\boxed{\Gamma \vdash \bar{t} : A}$

$$\frac{}{\{+\underline{\ell} : A\} \vdash \underline{\ell} : A}\ \textsc{TyTerm\_Ampar}$$

$$\frac{}{\{+h : A\} \vdash @h : A^{D}}\ \textsc{TyTerm\_Dest}$$

$$\frac{}{\{-h : A\} \vdash h : A}\ \textsc{TyTerm\_Hole}$$

$$\frac{}{\{\} \vdash () : \mathbf{1}}\ \textsc{TyTerm\_Unit}$$

$$\frac{\Gamma \vdash \bar{v} : A_1}{\Gamma \vdash \textsf{Inl}\,\bar{v} : A_1 \oplus A_2}\ \textsc{TyTerm\_Inl}$$

$$\frac{\Gamma \vdash \bar{v} : A_2}{\Gamma \vdash \textsf{Inr}\,\bar{v} : A_1 \oplus A_2}\ \textsc{TyTerm\_Inr}$$

$$\frac{\Gamma_1 \vdash \overline{v_1} : A_1 \quad \Gamma_2 \vdash \overline{v_2} : A_2}{\Gamma_1 \sqcup \Gamma_2 \vdash (\overline{v_1} \,,\, \overline{v_2}) : A_1 \otimes A_2}\ \textsc{TyTerm\_Prod}$$

$$\frac{\Gamma \sqcup \{x :_{m_1} A_1\} \vdash t : A_2}{\Gamma \vdash \lambda x\,.\,t : A_1\ {}_{m_1}\!\multimap A_2}\ \textsc{TyTerm\_Lambda}$$

$$\frac{\Gamma_1 \vdash t : A_1\ {}_{m_1}\!\multimap A_2 \quad \Gamma_2 \vdash u : A_1 \quad m_1 \in \textsf{upper\_modes}\,(\Gamma_2)}{\Gamma_1 \sqcup \Gamma_2 \vdash t\,u : A_2}\ \textsc{TyTerm\_App}$$

$$\frac{\Gamma_1 \vdash t : \mathbf{1} \quad \Gamma_2 \vdash u : B}{\Gamma_1 \sqcup \Gamma_2 \vdash t \succ \textsf{case}\,() \mapsto u : B}\ \textsc{TyTerm\_PatUnit}$$

$$\frac{\Gamma_1 \vdash t : A_1 \oplus A_2 \quad \exists m \in \textsf{upper\_modes}\,(\Gamma_1) \quad \Gamma_2 \sqcup \{x_1 :_m A_1\} \vdash u_1 : B \quad \Gamma_2 \sqcup \{x_2 :_m A_2\} \vdash u_2 : B}{\Gamma_1 \sqcup \Gamma_2 \vdash t \succ \textsf{case}\,\{\,\textsf{Inl}\,x_1 \mapsto u_1 \,,\ \textsf{Inr}\,x_2 \mapsto u_2\,\} : B}\ \textsc{TyTerm\_PatSum}$$

$$\frac{\Gamma_1 \vdash t : A_1 \otimes A_2 \quad \exists m \in \textsf{upper\_modes}\,(\Gamma_1) \quad \Gamma_2 \sqcup \{x_1 :_m A_1, x_2 :_m A_2\} \vdash u : B}{\Gamma_1 \sqcup \Gamma_2 \vdash t \succ \textsf{case}\,(x_1 \,,\, x_2) \mapsto u : B}\ \textsc{TyTerm\_PatProd}$$

$$\frac{\begin{array}{l}\Gamma_1 \vdash t : A_1 \ltimes A_2 \\ \exists\, m' \in \mathbf{upper\_modes}\,(\Gamma_1 \sqcup \Gamma_2) \\ m = \mathbf{if}\ F \in \mathbf{upper\_modes}\,(\Gamma_1)\ \mathbf{then}\ F\ \mathbf{else}\ L \\ \Gamma_2[L \mapsto F] \sqcup \{x :_m A_1\} \vdash u : B\end{array}}{\Gamma_1 \sqcup \Gamma_2 \vdash t \ \succ\mathbf{mapL}\ x \mapsto\ u : B \ltimes A_2} \quad \textsc{TyTerm\_MapAmpar}$$

$$\frac{}{\{\} \vdash \mathbf{alloc} : A^{D} \ltimes A} \quad \textsc{TyTerm\_Alloc}$$

$$\frac{\Gamma \vdash t : A}{\Gamma \vdash \mathbf{to}_{\ltimes}\ t : 1 \ltimes A} \quad \textsc{TyTerm\_ToAmpar}$$

$$\frac{\Gamma \vdash t : 1 \ltimes A}{\Gamma \vdash \mathbf{from}_{\ltimes}\ t : A} \quad \textsc{TyTerm\_FromAmpar}$$

$$\frac{\Gamma \vdash t : 1^{D}}{\Gamma \vdash t \triangleleft () : 1} \quad \textsc{TyTerm\_FillUnit}$$

$$\frac{\Gamma \vdash t : (A_1 \oplus A_2)^{D}}{\Gamma \vdash t \triangleleft \mathbf{Inl} : {A_1}^{D}} \quad \textsc{TyTerm\_FillInl}$$

$$\frac{\Gamma \vdash t : (A_1 \oplus A_2)^{D}}{\Gamma \vdash t \triangleleft \mathbf{Inr} : {A_2}^{D}} \quad \textsc{TyTerm\_FillInr}$$

$$\frac{\Gamma \vdash t : (A_1 \otimes A_2)^{D}}{\Gamma \vdash t \triangleleft (,) : {A_1}^{D} \otimes {A_2}^{D}} \quad \textsc{TyTerm\_FillProd}$$

$$\frac{\begin{array}{l}\Gamma_1 \vdash t : {A_2}^{D} \\ \Gamma_2 \vdash u : A_1 \ltimes A_2 \\ L \in \mathbf{upper\_modes}\,(\Gamma_1) \\ F \in \mathbf{upper\_modes}\,(\Gamma_2)\end{array}}{\Gamma_1 \sqcup \Gamma_2 \vdash t \triangleleft\!\bullet u : A_1} \quad \textsc{TyTerm\_FillCompL}$$

$$\frac{\begin{array}{l}\Gamma_1 \vdash t : {A_2}^{D} \\ \Gamma_2 \vdash u : A_1 \ltimes A_2 \\ F \in \mathbf{upper\_modes}\,(\Gamma_1) \\ G \in \mathbf{upper\_modes}\,(\Gamma_2)\end{array}}{\Gamma_1 \sqcup \Gamma_2 \vdash t \triangleleft\!\bullet u : A_1} \quad \textsc{TyTerm\_FillCompF}$$

$$\boxed{S \mid t \Downarrow S' \mid t'}$$

$$\frac{}{S_0 \mid v \Downarrow S_0 \mid v} \quad \textsc{BigStep\_Val}$$

$$\frac{\begin{array}{l}S_0 \mid t_1 \Downarrow S_1 \mid \lambda x\,.\,u \\ S_1 \mid t_2 \Downarrow S_2 \mid v_2 \\ S_2 \mid u[x := v_2] \Downarrow S_3 \mid v_3\end{array}}{S_0 \mid t_1\, t_2 \Downarrow S_3 \mid v_3} \quad \textsc{BigStep\_App}$$

$$\frac{\begin{array}{l}S_0 \mid t_1 \Downarrow S_1 \mid () \\ S_1 \mid t_2 \Downarrow S_2 \mid v_2\end{array}}{S_0 \mid t_1 \ \succ\mathbf{case}\ () \mapsto\ t_2 \Downarrow S_2 \mid v_2} \quad \textsc{BigStep\_PatUnit}$$

$$\frac{\begin{array}{l}S_0 \mid t \Downarrow S_1 \mid \mathbf{Inl}\, v_1 \\ S_1 \mid u_1[x_1 := v_1] \Downarrow S_2 \mid v_2\end{array}}{S_0 \mid t \ \succ\mathbf{case}\,\{\,\mathbf{Inl}\, x_1 \mapsto u_1\,,\ \mathbf{Inr}\, x_2 \mapsto u_2\,\} \Downarrow S_2 \mid v_2} \quad \textsc{BigStep\_PatInl}$$

$$\frac{\begin{array}{l}S_0 \mid t \Downarrow S_1 \mid \mathbf{Inr}\, v_1 \\ S_1 \mid u_2[x_2 := v_1] \Downarrow S_2 \mid v_2\end{array}}{S_0 \mid t \ \succ\mathbf{case}\,\{\,\mathbf{Inl}\, x_1 \mapsto u_1\,,\ \mathbf{Inr}\, x_2 \mapsto u_2\,\} \Downarrow S_2 \mid v_2} \quad \textsc{BigStep\_PatInr}$$

$$\frac{\begin{array}{l}S_0 \mid t \Downarrow S_1 \mid (v_1\,,\ v_2) \\ S_1 \mid u[x_1 := v_1, x_2 := v_2] \Downarrow S_2 \mid v_2\end{array}}{S_0 \mid t \ \succ\mathbf{case}\,(x_1\,,\ x_2) \mapsto\ u \Downarrow S_2 \mid v_2} \quad \textsc{BigStep\_PatProd}$$

$$\frac{\begin{array}{c}\mathsf{S}_0 \mid \mathsf{t} \Downarrow \mathsf{S}_1 \sqcup [\,\ell \mapsto \langle \mathsf{v}_1 \,,\, \overline{\mathsf{v}_2} \rangle\,] \mid \ell \\ \mathsf{S}_1 \sqcup [\,\ell \mapsto \langle \blacksquare \,,\, \overline{\mathsf{v}_2} \rangle\,] \mid \mathsf{u}[\mathsf{x} := \mathsf{v}_1] \Downarrow \mathsf{S}_2 \sqcup [\,\ell \mapsto \langle \blacksquare \,,\, \overline{\mathsf{v}_4} \rangle\,] \mid \mathsf{v}_3\end{array}}{\mathsf{S}_0 \mid \mathsf{t}\ \succ\!\mathbf{mapL}\ \mathsf{x} \mapsto \mathsf{u} \Downarrow \mathsf{S}_2 \sqcup [\,\ell \mapsto \langle \mathsf{v}_3 \,,\, \overline{\mathsf{v}_4} \rangle\,] \mid \ell} \quad \textsc{BigStep\_MapAmpar}$$

$$\frac{\begin{array}{c}\mathbf{fresh}\ h \\ \mathbf{fresh}\ \ell\end{array}}{\mathsf{S}_0 \mid \mathbf{alloc} \Downarrow \mathsf{S}_0 \sqcup [\,\ell \mapsto \langle @h \,,\, h \rangle\,] \mid \ell} \quad \textsc{BigStep\_Alloc}$$

$$\frac{\begin{array}{c}\mathsf{S}_0 \mid \mathsf{t} \Downarrow \mathsf{S}_1 \mid \mathsf{v} \\ \mathbf{fresh}\ \ell\end{array}}{\mathsf{S}_0 \mid \mathbf{to}_\ltimes\ \mathsf{t} \Downarrow \mathsf{S}_1 \sqcup [\,\ell \mapsto \langle () \,,\, \mathsf{v} \rangle\,] \mid \ell} \quad \textsc{BigStep\_ToAmpar}$$

$$\frac{\mathsf{S}_0 \mid \mathsf{t} \Downarrow \mathsf{S}_1 \sqcup [\,\ell \mapsto \langle () \,,\, \mathsf{v} \rangle\,] \mid \ell}{\mathsf{S}_0 \mid \mathbf{from}_\ltimes\ \mathsf{t} \Downarrow \mathsf{S}_1 \mid \mathsf{v}} \quad \textsc{BigStep\_FromAmpar}$$

$$\frac{\mathsf{S}_0 \mid \mathsf{t} \Downarrow \mathsf{S}_1 \mid @h}{\mathsf{S}_0 \mid \mathsf{t} \triangleleft () \Downarrow \mathsf{S}_1[h := ()] \mid ()} \quad \textsc{BigStep\_FillUnit}$$

$$\frac{\begin{array}{c}\mathsf{S}_0 \mid \mathsf{t} \Downarrow \mathsf{S}_1 \mid @h \\ \mathbf{fresh}\ h'\end{array}}{\mathsf{S}_0 \mid \mathsf{t} \triangleleft \mathbf{Inl} \Downarrow \mathsf{S}_1[h := \mathbf{Inl}\ h'] \mid @h'} \quad \textsc{BigStep\_FillInl}$$

$$\frac{\begin{array}{c}\mathsf{S}_0 \mid \mathsf{t} \Downarrow \mathsf{S}_1 \mid @h \\ \mathbf{fresh}\ h'\end{array}}{\mathsf{S}_0 \mid \mathsf{t} \triangleleft \mathbf{Inr} \Downarrow \mathsf{S}_1[h := \mathbf{Inr}\ h'] \mid @h'} \quad \textsc{BigStep\_FillInr}$$

$$\frac{\begin{array}{c}\mathsf{S}_0 \mid \mathsf{t} \Downarrow \mathsf{S}_1 \mid @h \\ \mathbf{fresh}\ h_1 \\ \mathbf{fresh}\ h_2\end{array}}{\mathsf{S}_0 \mid \mathsf{t} \triangleleft (,) \Downarrow \mathsf{S}_1[h := (h_1 \,,\, h_2)] \mid (@h_1 \,,\, @h_2)} \quad \textsc{BigStep\_FillProd}$$

$$\frac{\begin{array}{c}\mathsf{S}_0 \mid \mathsf{t} \Downarrow \mathsf{S}_1 \mid @h \\ \mathsf{S}_1 \mid \mathsf{u} \Downarrow \mathsf{S}_2 \sqcup [\,\ell \mapsto \langle \mathsf{v}_1 \,,\, \overline{\mathsf{v}_2} \rangle\,] \mid \ell\end{array}}{\mathsf{S}_0 \mid \mathsf{t} \triangleleft\!\bullet\, \mathsf{u} \Downarrow \mathsf{S}_2[h := \overline{\mathsf{v}_2}] \mid \mathsf{v}_1} \quad \textsc{BigStep\_FillComp}$$

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Definition rules:         42 good    0 bad
Definition rule clauses: 114 good    0 bad
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