

# Typing Rules and Evaluation rules

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## 1 Fork

$$\frac{\Gamma|\mathbb{L} \vdash t : T}{fork\{ t \} : Thread\ T} \quad (\text{T-FORK})$$

$$\frac{t_1 \rightarrow t'_1}{fork\{ t_1 \} \rightarrow fork\{ t'_1 \}} \quad (\text{E-FORK})$$

$$\frac{\Gamma|\mathbb{L} \vdash t : Thread\ T}{wait\ t : T} \quad (\text{T-WAIT})$$

$$\frac{t \rightarrow t'}{wait\ t \rightarrow wait\ t'} \quad (\text{E-WAIT})$$

$$\frac{\Gamma|\mathbb{L} \vdash t : Thread\ T}{wait\ t : T} \quad (\text{T-WAITFORK})$$

$$\frac{t_1 \rightarrow t'_1}{wait\ t_1 \rightarrow wait\ t'_1} \quad (\text{E-FORK})$$

$$wait\ fork\{ v \} \rightarrow v \quad (\text{E-WAITFORK})$$

## 2 Mutex

$$\frac{}{\Gamma|\mathbb{L} \vdash \text{mutex} < X > : \text{Mutex } X} \quad (\text{T-MUTEX})$$

$$\frac{\Gamma|\mathbb{L} \vdash x : \text{Mutex } X \quad \Gamma \vdash v : T}{\text{ref} < x > v : \text{Ref} < X > T} \quad (\text{T-REFMUTEX})$$

$$\frac{t_1 \rightarrow t'_1}{\text{ref} < x > t_1 \rightarrow \text{ref} < x > t'_1} \quad (\text{E-REFMUTEX})$$

$$\frac{\Gamma|\mathbb{L} \vdash t_1 : \text{Ref} < X > T \quad X \in \mathbb{L}}{\Gamma|\mathbb{L} \vdash !t_1 : T} \quad (\text{T-DEREFMUTEX})$$

$$\frac{\Gamma|\mathbb{L} \vdash t_1 : \text{Ref} < X > T \quad \Gamma \vdash t_2 : T \quad X \in \mathbb{L}}{\Gamma|\mathbb{L} \vdash t_1 := t_2 : \text{Unit}} \quad (\text{T-ASSIGNMUTEX})$$

$$\frac{t_1|\mu \rightarrow t'_1|\mu'}{\text{ref} < x > t_1|\mu \rightarrow \text{ref} < x > t_1|\mu} \quad (\text{E-REFMUTEX})$$

$$\frac{l \notin \text{dom}(\mu)}{\text{ref} < x > v|\mu \rightarrow l|\mu, l \mapsto v} \quad (\text{E-REFV})$$

$$\frac{t_1|\mu \rightarrow t'_1|\mu'}{!t_1|\mu \rightarrow !t'_1|\mu} \quad (\text{E-DEREF})$$

$$\frac{\mu(l) = v}{!l|\mu \rightarrow v|\mu} \quad (\text{E-DEREFLOC})$$

$$\frac{t_1|\mu \rightarrow t'_1|\mu'}{t_1 := t_2|\mu \rightarrow t'_1 := t_2|\mu} \quad (\text{E-ASSIGN1})$$

$$\frac{t_2|\mu \rightarrow t'_2|\mu'}{v := t_2|\mu \rightarrow v := t'_2|\mu} \quad (\text{E-ASSIGN2})$$

$$\frac{\mu(l) = v}{l := v|\mu \rightarrow \text{unit}|\mu, l \mapsto v} \quad (\text{E-ASSIGNV})$$

$$\frac{\Gamma|\mathbb{L} \vdash t_1 : \text{Ref} < X > T \quad \Gamma \vdash t_2 : T \quad X \in \mathbb{L}}{\Gamma|\mathbb{L} \vdash t_1 := t_2 : \text{Unit}} \quad (\text{S-REFMUTEX})$$

### 3 Lock

$$\frac{\text{tail}(\mathbb{L}) <_{lex} X \quad \Gamma|\mathbb{L} \vdash t_1 : \text{Mutex } X \quad \Gamma|(\mathbb{L}, X) \vdash t_2 : T}{\text{lock } t_1 \ t_2 : T} \quad (\text{T-LOCK})$$

$$\frac{t_1 \rightarrow t'_1}{\text{lock } t_1 \ t_2 \rightarrow \text{lock } t'_1 \ t_2} \quad (\text{E-LOCK1})$$

$$\frac{t_2 \rightarrow t'_2}{\text{lock } v_1 \ t_2 \rightarrow \text{lock } v_1 \ t'_2} \quad (\text{E-LOCK2})$$

$$\text{lock } v_1 \ v_2 \rightarrow v_2 \quad (\text{E-LOCKV})$$