

Typing

Types of expressions:

$$T ::= \text{int} \mid \text{bool} \mid \text{unit}$$

Types of locations:

$$T_{loc} ::= \text{intref}$$

Write \mathbf{T} and \mathbf{T}_{loc} for the sets of all terms of these grammars.

Let Γ range over $\mathbf{TypeEnv}$, the finite partial functions from locations \mathbb{L} to \mathbf{T}_{loc} .

$$(\text{int}) \quad \Gamma \vdash n:\text{int} \quad \text{for } n \in \mathbb{Z}$$

$$(\text{bool}) \quad \Gamma \vdash b:\text{bool} \quad \text{for } b \in \{\mathbf{true}, \mathbf{false}\}$$

$$(\text{op } +) \quad \frac{\Gamma \vdash e_1:\text{int} \quad \Gamma \vdash e_2:\text{int}}{\Gamma \vdash e_1 + e_2:\text{int}} \qquad (\text{op } \geq) \quad \frac{\Gamma \vdash e_1:\text{int} \quad \Gamma \vdash e_2:\text{int}}{\Gamma \vdash e_1 \geq e_2:\text{bool}}$$

$$(\text{if}) \quad \frac{\Gamma \vdash e_1:\text{bool} \quad \Gamma \vdash e_2:T \quad \Gamma \vdash e_3:T}{\Gamma \vdash \mathbf{if } e_1 \mathbf{ then } e_2 \mathbf{ else } e_3:T}$$

$$(\text{assign}) \quad \frac{\Gamma(\ell) = \text{intref} \quad \Gamma \vdash e:\text{int}}{\Gamma \vdash \ell := e:\text{unit}}$$

$$(\text{deref}) \quad \frac{\Gamma(\ell) = \text{intref}}{\Gamma \vdash !\ell:\text{int}}$$

$$(\text{skip}) \quad \Gamma \vdash \mathbf{skip}:\text{unit}$$

$$(\text{seq}) \quad \frac{\Gamma \vdash e_1:\text{unit} \quad \Gamma \vdash e_2:T}{\Gamma \vdash e_1; e_2:T}$$

$$(\text{while}) \quad \frac{\Gamma \vdash e_1:\text{bool} \quad \Gamma \vdash e_2:\text{unit}}{\Gamma \vdash \mathbf{while } e_1 \mathbf{ do } e_2:\text{unit}}$$