

| | | | |
|--------------------------|----------|---|------------------|
| var, x | variable | | |
| \mathbf{n}, \mathbf{n} | name | | |
| $type, S, T$ | $::=$ | | type |
| | | o | bool |
| | | ν | name |
| | | $S \rightarrow T$ | function |
| | | (T) | S |
| $term, e$ | $::=$ | | term |
| | | x | variable |
| | | true | true |
| | | false | false |
| | | n | name |
| | | new | new |
| | | $e_1 = e_2$ | equal |
| | | if e_1 then e_2 else e_3 | conditional |
| | | $\lambda x:T.e$ | bind x in e |
| | | $e_1 e_2$ | application |
| | | (e) | S |
| | | $\{e_1/x\}e_2$ | M |
| $value, v$ | $::=$ | | value |
| | | true | true |
| | | false | false |
| | | n | name |
| | | $\lambda x:T.e$ | bind x in e |
| env, E | $::=$ | | type environment |
| | | empty | |
| | | $env, x : T$ | |
| $nameset, s$ | $::=$ | | |
| | | $s_1 \cup s_2$ | |
| | | $\{\mathbf{n}\}$ | |
| nat, k | $::=$ | | |
| | | 0 | |
| | | $k_1 + k_2$ | |
| $formula$ | $::=$ | | |
| | | <i>judgement</i> | |
| | | $x : T \in env$ | |
| | | $\mathbf{n} \in s$ | |
| | | $\mathbf{n} \notin s$ | |
| | | $\mathbf{n} / = \mathbf{n}$ | |
| | | $\vdash env$ | |
| | | $k_1 < k_2$ | |

| | | | | |
|--------------------|-----|--|-------------------------------------|---------------------------|
| <i>terminals</i> | ::= | | λ | |
| | | | \longrightarrow | |
| | | | \rightarrow | |
| | | | \vdash | |
| | | | \cup | |
| | | | \in | |
| | | | \notin | |
| | | | new | |
| | | | true | |
| | | | false | |
| | | | if | |
| | | | then | |
| | | | else | |
| <i>Jtype</i> | ::= | | $s; E \vdash e : T$ | |
| <i>Jop</i> | ::= | | $s_1 \vdash e \Downarrow^k (s_2) v$ | evaluation with a measure |
| <i>judgement</i> | ::= | | <i>Jtype</i> | |
| | | | <i>Jop</i> | |
| <i>user_syntax</i> | ::= | | <i>var</i> | |
| | | | n | |
| | | | <i>type</i> | |
| | | | <i>term</i> | |
| | | | <i>value</i> | |
| | | | <i>env</i> | |
| | | | <i>nameset</i> | |
| | | | <i>nat</i> | |
| | | | <i>formula</i> | |
| | | | <i>terminals</i> | |

$s; E \vdash e : T$

| | |
|---|--------------|
| $\vdash E$ | |
| $\frac{x : T \in E}{s; E \vdash x : T}$ | TYPING_VAR |
| $\vdash E$ | |
| $\frac{\vdash E}{s; E \vdash \mathbf{true} : o}$ | TYPING_TRUE |
| $\vdash E$ | |
| $\frac{\vdash E}{s; E \vdash \mathbf{false} : o}$ | TYPING_FALSE |
| $\vdash E$ | |
| $\frac{\mathbf{n} \in s}{s; E \vdash \mathbf{n} : \nu}$ | TYPING_NAME |

$$\begin{array}{c}
\frac{}{s; E \vdash \mathbf{new} : \nu} \text{ TYPING_NEW} \\
\frac{s; E \vdash e_1 : T \quad s; E \vdash e_2 : T}{s; E \vdash e_1 = e_2 : o} \text{ TYPING_EQN} \\
\frac{s; E \vdash e_1 : o \quad s; E \vdash e_2 : T \quad s; E \vdash e_3 : T}{s; E \vdash \mathbf{if } e_1 \mathbf{ then } e_2 \mathbf{ else } e_3 : T} \text{ TYPING_COND} \\
\frac{s; E, x : S \vdash e : T}{s; E \vdash \lambda x : S. e : S \rightarrow T} \text{ TYPING_ABS} \\
\frac{s; E \vdash e_1 : S \rightarrow T \quad s; E \vdash e_2 : S}{s; E \vdash e_1 e_2 : T} \text{ TYPING_APPLY}
\end{array}$$

$s_1 \vdash e \Downarrow^k (s_2) v$

evaluation with a measure

$$\begin{array}{c}
\frac{}{s \vdash v \Downarrow^k () v} \text{ CAN} \\
\frac{s_1 \vdash e_1 \Downarrow^{k_1} (s_2) \mathbf{true} \quad s_1 \cup s_2 \vdash e_2 \Downarrow^{k_2} (s_3) v \quad k_1 + k_2 < k}{s_1 \vdash \mathbf{if } e_1 \mathbf{ then } e_2 \mathbf{ else } e_3 \Downarrow^k (s_2 \cup s_3) v} \text{ COND1} \\
\frac{s_1 \vdash e_1 \Downarrow^{k_1} (s_2) \mathbf{false} \quad s_1 \cup s_2 \vdash e_3 \Downarrow^{k_2} (s_3) v \quad k_1 + k_2 < k}{s_1 \vdash \mathbf{if } e_1 \mathbf{ then } e_2 \mathbf{ else } e_3 \Downarrow^k (s_2 \cup s_3) v} \text{ COND2} \\
\frac{s_1 \vdash e_1 \Downarrow^{k_1} (s_2) \lambda x : T. e_3 \quad s_1 \cup s_2 \vdash e_2 \Downarrow^{k_2} (s_3) v_4 \quad s_1 \cup s_2 \cup s_3 \vdash (\lambda x : T. e_3) v_4 \Downarrow^{k_2} (s_4) v \quad k_1 + k_2 + k_3 < k}{s_1 \vdash e_1 e_2 \Downarrow^k (s_2 \cup s_3 \cup s_4) v} \text{ APP} \\
\frac{s_1 \vdash e_1 \Downarrow^{k_1} (s_2) \mathbf{n} \quad s_1 \cup s_2 \vdash e_2 \Downarrow^{k_2} (s_3) \mathbf{n} \quad k_1 + k_2 < k}{s_1 \vdash e_1 = e_2 \Downarrow^k (s_2 \cup s_3) \mathbf{true}} \text{ EQ1} \\
\frac{s_1 \vdash e_1 \Downarrow^{k_1} (s_2) \mathbf{n} \quad s_1 \cup s_2 \vdash e_2 \Downarrow^{k_2} (s_3) \mathbf{n} \quad \mathbf{n} / = \mathbf{n} \quad k_1 + k_2 < k}{s_1 \vdash e_1 = e_2 \Downarrow^k (s_2 \cup s_3) \mathbf{true}} \text{ EQ2} \\
\frac{\mathbf{n} \notin s \quad 0 < k}{s \vdash \mathbf{new} \Downarrow^k (\{\mathbf{n}\}) \mathbf{n}} \text{ AX_APP}
\end{array}$$

Definition rules: 16 good 0 bad
Definition rule clauses: 50 good 0 bad