

Evaluation Rules

[E-SUCC-CTX]

$$\frac{e \rightarrow e'}{\text{succ } e \rightarrow \text{succ } e'}$$

[E-SUCC]

$$\frac{}{\text{succ } i \rightarrow i + 1}$$

[E-PRED-CTX]

$$\frac{e \rightarrow e'}{\text{pred } e \rightarrow \text{pred } e'}$$

[E-PRED]

$$\frac{}{\text{pred } i \rightarrow i - 1}$$

[E-ISZERO-CTX]

$$\frac{e \rightarrow e'}{\text{iszero } e \rightarrow \text{iszero } e'}$$

[E-ISZERO-ZERO]

$$\frac{}{\text{iszero } 0 \rightarrow \text{true}}$$

[E-ISZERO-NONZERO]

$$\frac{i \neq 0}{\text{iszero } \text{succ } i \rightarrow \text{false}}$$

[E-IF-CTX]

$$\frac{e_1 \rightarrow e'_1}{\text{if } e_1 \text{ then } e_2 \text{ else } e_3 \rightarrow \text{if } e'_1 \text{ then } e_2 \text{ else } e_3}$$

[E-IF-TRUE]

$$\frac{}{\text{if true then } e_2 \text{ else } e_3 \rightarrow e_2}$$

[E-IF-FALSE]

$$\frac{}{\text{if false then } e_2 \text{ else } e_3 \rightarrow e_3}$$

[E-CONCAT-CTX1]

$$\frac{e_1 \rightarrow e'_1}{\text{concat } e_1 e_2 \rightarrow \text{concat } e'_1 e_2}$$

[E-CONCAT-CTX2]

$$\frac{e_2 \rightarrow e'_2}{\text{concat } s_1 e_2 \rightarrow \text{concat } s_1 e'_2}$$

[E-CONCAT]

$$\frac{s_3 = s_1 + s_2}{\text{concat } s_1 s_2 \rightarrow s_3}$$

[E-ISEMPTYSTR-CTX]

$$\frac{e \rightarrow e'}{\text{isemptystr } e \rightarrow \text{isemptystr } e'}$$

[E-ISEMPTYSTR-EMPTY]

$$\frac{}{\text{isemptystr } "" \rightarrow \text{true}}$$

[E-ISEMPTYSTR-NONEMPTY]

$$\frac{s \neq ""}{\text{isemptystr } s \rightarrow \text{false}}$$

[E-STRLEN-CTX]

$$\frac{e \rightarrow e'}{\text{strlen } e \rightarrow \text{strlen } e'}$$

[E-STRLEN-ZERO]

$$\frac{}{\text{strlen } "" \rightarrow 0}$$

[E-STRLEN-NONZERO]

$$\frac{c \text{ is a single char, } s = c + s'}{\text{strlen } s \rightarrow \text{succ } \text{strlen } s'}$$

Typing Rules

[T-TRUE]

$$\frac{}{\text{true} : \text{Bool}}$$

[T-FALSE]

$$\frac{}{\text{false} : \text{Bool}}$$

[T-INT]

$$\frac{}{n : \text{Int}}$$

[T-STRING]

$$\frac{}{s : \text{String}}$$

[T-SUCC]

$$\frac{e : \text{Int}}{\text{succ } e : \text{Int}}$$

[T-PRED]

$$\frac{e : \text{Int}}{\text{pred } e : \text{Int}}$$

[T-ISZERO]

$$\frac{e : \text{Int}}{\text{iszero } e : \text{Bool}}$$

[T-IF]

$$\frac{e_1 : \text{Bool}, e_2 : T, e_3 : T}{\text{if } e_1 \text{ then } e_2 \text{ else } e_3 : T}$$

[T-CONCAT]

$$\frac{e_1 : \text{String}, e_2 : \text{String}}{\text{concat } e_1 e_2 : \text{String}}$$

[T-ISEMPTYSTR]

$$\frac{e : \text{String}}{\text{isemptystr } e : \text{Bool}}$$

[T-STRLEN]

$$\frac{e : \text{String}}{\text{strlen } e : \text{Int}}$$