Review

Rules and derivations

Syntax and evaluation

Rule:

$$\frac{\text{premise}_1 \quad \cdots \quad \text{premise}_n \quad \text{(maybe none)}}{\text{conclusion}}$$

Meta-variables (n, v, e, ...) get replaced.

$$\frac{e1 \Downarrow (\text{Num } n1) \quad e2 \Downarrow (\text{Num } n2)}{(\text{Add } e1\ e2) \Downarrow (\text{Num } n1+n2)}\ \text{Eval-add}$$

Equals can be replaced with equals:

$$\frac{\dfrac{}{(\text{Num } 1) \Downarrow (\text{Num } 1)}\ \text{Eval-num} \qquad \dfrac{}{(\text{Num } 5) \Downarrow (\text{Num } 5)}\ \text{Eval-num}}{(\text{Add } (\text{Num } 1)\ (\text{Num } 5)) \Downarrow (\text{Num } 6)}\ \text{Eval-add}$$

↑ was $n1 + n2$, $1 + 5$, 6

$$\frac{}{(\text{Num } n) \Downarrow (\text{Num } n)}\ \text{Eval-num}$$

is "just notation" for

$$\frac{}{(\text{Num } 0) \Downarrow (\text{Num } 0)} \qquad \frac{}{(\text{Num } 1) \Downarrow (\text{Num } 1)}$$

$$\frac{}{(\text{Num } -1) \Downarrow (\text{Num } -1)} \qquad \frac{}{(\text{Num } -2) \Downarrow (\text{Num } -2)}$$

$$\vdots$$

$$\frac{\dfrac{}{(\text{Num } 3) \Downarrow (\text{Num } 3)}\ \text{Eval-num} \qquad \dfrac{\dfrac{}{(\text{Num } 3) \Downarrow (\text{Num } 3)}\ \text{Eval-num} \qquad \dfrac{}{(\text{Num } 1) \Downarrow (\text{Num } 1)}\ \text{Eval-num}}{(\text{Add } (\text{Num } 3)\ (\text{Num } 1)) = [(\text{Num } 3)/z](\text{Add } (\text{Id } z)\ (\text{Num } 1)) \Downarrow (\text{Num } 3+1)}\ \text{Eval-add}}{(\text{Let } z\ (\text{Num } 3)\ (\text{Add } (\text{Id } z)\ (\text{Num } 1))) \Downarrow (\text{Num } 4)}\ \text{Eval-let}$$

z = x, (Num 3) = e1, (Add (Id z) (Num 1)) = e2

$$[(\text{Num } 3)/z](\text{Add } (\text{Id } z)\ (\text{Num } 1))$$
$$= (\text{Add } [(\text{Num } 3)/z](\text{Id } z)\ [(\text{Num } 3)/z](\text{Num } 1))$$
$$= (\text{Add } (\text{Num } 3)\ (\text{Num } 1))$$

Strings

- Syntax
  - Concrete syntax } parse ⇢ unparse
  - abstract syntax
- semantics
  - evaluation rules interp
  - substitution. subst

⟨E⟩ ::= ... | ⟨string⟩.
| {Cat ⟨E⟩ ⟨E⟩} append/concat
| {Nth ⟨E⟩ ⟨E⟩}

(define-type E
...
[Str (s string?)]
[Cat (left E?) (right E?)]
[Nth (s ~~string?~~ E?) (index E?)]
)

$$\frac{e1 \Downarrow (\text{Str } s1) \quad e2 \Downarrow (\text{Str } s2)}{(\text{Cat } e1\ e2) \Downarrow (\text{Str } s1s2)}\ \text{Eval-cat}$$

$$\frac{}{(\text{Str } s) \Downarrow (\text{Str } s)}\ \text{Eval-str}$$

$$\frac{e1 \Downarrow v1 \quad e2 \Downarrow v2}{(\text{Cat } e1\ e2) \Downarrow (\text{Str } v1v2)}$$

c is one character

$$\frac{eStr \Downarrow (\text{Str } c_1 \cdots c_n) \quad eIdx \Downarrow (\text{Num } i) \quad i \in \mathbb{Z}^+ \quad i \le n}{(\text{Nth } eStr\ eIdx) \Downarrow (\text{Str } c_i)}$$

$$\frac{eStr \Downarrow (\text{Str } s) \quad eIdx \Downarrow (\text{Num } i) \quad i \in \mathbb{Z} \quad i \ge 0 \quad i \le n}{(\text{Nth } eStr\ eIdx) \Downarrow (\text{Str } s_i)}$$