PLTI HW1

Matthew Retchin

October 2024

Introduction

I extended the STLC to have linked lists, define, begin, car, and cdr.

My interpreter doesn't have variable capture issues by always reducing variables to values (numbers and booleans) before applying abstractions to them.

Big-Step Evaluation Rules

(E-Var)

$$\frac{\rho(x) = v}{\rho \vdash x \Downarrow v} \tag{1}$$

(E-Abs)

$$\frac{}{\rho \vdash \lambda x.e \Downarrow \langle \lambda x.e, \rho \rangle} \tag{2}$$

(E-App)

$$\frac{\rho \vdash e_1 \Downarrow \langle \lambda x.e', \rho' \rangle \quad \rho \vdash e_2 \Downarrow v_2 \quad \rho'[x \mapsto v_2] \vdash e' \Downarrow v}{\rho \vdash e_1\ e_2 \Downarrow v} \tag{3}$$

(E-IfTrue)

$$\frac{\rho \vdash e_1 \Downarrow \text{True} \quad \rho \vdash e_2 \Downarrow v}{\rho \vdash \text{if } e_1 \text{ then } e_2 \text{ else } e_3 \Downarrow v} \tag{4}$$

(E-IfFalse)

$$\frac{\rho \vdash e_1 \Downarrow \text{False} \quad \rho \vdash e_3 \Downarrow v}{\rho \vdash \text{if } e_1 \text{ then } e_2 \text{ else } e_3 \Downarrow v} \tag{5}$$

(E-Add)

$$\frac{\rho \vdash e_1 \Downarrow \text{Num}(n_1) \quad \rho \vdash e_2 \Downarrow \text{Num}(n_2)}{\rho \vdash e_1 + e_2 \Downarrow \text{Num}(n_1 + n_2)} \tag{6}$$

(E-Cons)

$$\frac{\rho \vdash e_1 \Downarrow v_1 \quad \rho \vdash e_2 \Downarrow v_2}{\rho \vdash \text{Cons}(e_1, e_2) \Downarrow \text{Cons}(v_1, v_2)} \tag{7}$$

(E-Car)

$$\frac{\rho \vdash e \Downarrow \text{Cons}(v_1, v_2)}{\rho \vdash \text{Car}(e) \Downarrow v_1} \tag{8}$$

(E-Cdr)

$$\frac{\rho \vdash e \Downarrow \text{Cons}(v_1, v_2)}{\rho \vdash \text{Cdr}(e) \Downarrow v_2} \tag{9}$$

(E-Begin)

$$\frac{\rho \vdash e_1 \Downarrow v_1 \quad \rho \vdash e_2 \Downarrow v_2 \quad \ldots \quad \rho \vdash e_n \Downarrow v_n}{\rho \vdash \text{Begin}(e_1, e_2, \ldots, e_n) \Downarrow v_n} \tag{10}$$

(E-Nil)

$$\frac{}{\rho \vdash \text{Nil} \Downarrow \text{Nil}} \tag{11}$$

(E-Define)

$$\frac{\rho \vdash e \Downarrow v}{\rho[x \mapsto v] \vdash \text{Define}(x, e) \Downarrow v} \tag{12}$$

Typing Rules

(T-Var)

$$\frac{x : \tau \in \Gamma}{\Gamma \vdash x : \tau} \tag{13}$$

(T-Abs)

$$\frac{\Gamma, x : \tau_1 \vdash e : \tau_2}{\Gamma \vdash \lambda x.e : \tau_1 \to \tau_2} \tag{14}$$

(T-App)

$$\frac{\Gamma \vdash e_1 : \tau_1 \to \tau_2 \quad \Gamma \vdash e_2 : \tau_1}{\Gamma \vdash e_1 \ e_2 : \tau_2} \tag{15}$$

(T-If)

$$\frac{\Gamma \vdash e_1 : \text{Bool} \quad \Gamma \vdash e_2 : \tau \quad \Gamma \vdash e_3 : \tau}{\Gamma \vdash \text{if } e_1 \text{ then } e_2 \text{ else } e_3 : \tau} \tag{16}$$

(T-Add)

$$\frac{\Gamma \vdash e_1 : \text{Int} \quad \Gamma \vdash e_2 : \text{Int}}{\Gamma \vdash e_1 + e_2 : \text{Int}} \tag{17}$$

(T-Cons)

$$\frac{\Gamma \vdash e_1 : \tau \quad \Gamma \vdash e_2 : \text{List}(\tau)}{\Gamma \vdash \text{Cons}(e_1, e_2) : \text{List}(\tau)} \tag{18}$$

(T-Nil)

$$\frac{}{\Gamma \vdash \text{Nil} : \text{List}(\tau)} \tag{19}$$

(T-Num)

$$\frac{}{\Gamma \vdash n : \text{Int}} \quad \text{where } n \in \mathbb{Z} \tag{20}$$

(T-Bool)

$$\frac{}{\Gamma \vdash \text{True} : \text{Bool}} \quad \frac{}{\Gamma \vdash \text{False} : \text{Bool}} \tag{21}$$

(T-Car)

$$\frac{\Gamma \vdash e : \text{List}(\tau)}{\Gamma \vdash \text{Car}(e) : \tau} \tag{22}$$

(T-Cdr)

$$\frac{\Gamma \vdash e : \text{List}(\tau)}{\Gamma \vdash \text{Cdr}(e) : \text{List}(\tau)} \tag{23}$$

(T-Begin)

$$\frac{\Gamma \vdash e_1 : \tau_1 \quad \Gamma \vdash e_2 : \tau_2 \quad \ldots \quad \Gamma \vdash e_n : \tau_n}{\Gamma \vdash \text{Begin}(e_1, e_2, \ldots, e_n) : \tau_n} \tag{24}$$

(T-Define)

$$\frac{\Gamma \vdash e : \tau}{\Gamma, x : \tau \vdash \text{Define}(x, e) : \tau} \tag{25}$$