Comp 105: Programming Languages — Amy Bui
Homework 2 — abui02

Calculational proof

Here are some examples of LaTeXcommands that could help you write a calculational proof.

Writing a code chunk on a line: `(length (append xs ys))`.

And here's a chunk of a calculational proof:

$$
\begin{aligned}
&\texttt{(length (append xs ys))}\\
&\quad = \{\text{ by assumption, } \texttt{xs} = \texttt{(cons z zs)} \}\\
&\texttt{(length (append (cons z zs) ys))}\\
&\quad = \{\text{ append-cons law }\}\\
&\texttt{(length (cons z (append zs ys))}
\end{aligned}
$$

Inference Rules

Verbatim code: `(if x 2 3)`

Another way to put text in code font: `x`.

Putting text in the font to name rules: IFFALSE.

$$\frac{}{\langle \textsc{literal}(v), \xi, \phi, \rho\rangle \Downarrow \langle v, \xi, \phi, \rho\rangle}\ \textsc{Literal}$$

$$\frac{x \in \texttt{dom}\ \rho}{\langle \textsc{var}(x), \xi, \phi, \rho\rangle \Downarrow \langle \rho(x), \xi, \phi, \rho\rangle}\ \textsc{FormalVar}$$

LITERAL to LIT):

$$\textsc{FormalAssign}\ \frac{\texttt{n} \in \texttt{dom}\ \rho \qquad \dfrac{}{\langle \textsc{lit}(0), \xi, \phi, \rho\rangle \Downarrow \langle 0, \xi, \phi, \rho\rangle}\ \textsc{Literal}}{\langle \textsc{set}(\textsc{var}(\texttt{n}), \textsc{lit}(0)), \xi, \phi, \rho\rangle \Downarrow \langle 0, \xi, \phi, \rho\{\texttt{n} \mapsto 0\}\rangle}$$

$$\frac{\langle e_1, \xi, \phi, \rho\rangle \Downarrow \langle v_1, \xi', \phi, \rho'\rangle \quad v_1 = 0}{\langle \textsc{while}(e_1, e_2), \xi, \phi, \rho\rangle \Downarrow \langle 0, \xi', \phi, \rho'\rangle}\ (\textsc{WhileEnd})$$

$$\frac{x \in \texttt{dom}\ \rho}{\langle \textsc{var}(x), \xi, \phi, \rho\rangle \Downarrow \langle \rho(x), \xi, \phi, \rho\rangle}\ (\textsc{FormalVar})$$

$$\frac{x \in \texttt{dom}\,\rho \qquad \langle e, \xi, \phi, \rho \rangle \Downarrow \langle v, \xi', \phi, \rho' \rangle}{\langle \text{SET}(x, e), \xi, \phi, \rho \rangle \Downarrow \langle v, \xi', \phi, \rho'\{x \mapsto v\} \rangle} \text{ (FORMALASSIGN)}$$

$$\frac{x \notin \mathsf{dom}\,\rho \qquad x \in \mathsf{dom}\,\xi}{\langle \text{VAR}(x), \xi, \phi, \rho \rangle \Downarrow \langle \xi(x), \xi, \phi, \rho \rangle} \text{ (GLOBALVAR)}$$

$$\frac{x \notin \mathsf{dom}\,\rho \qquad x \in \mathsf{dom}\,\xi \qquad \langle e, \xi, \phi, \rho \rangle \Downarrow \langle v, \xi', \phi, \rho' \rangle}{\langle \text{SET}(x, e), \xi, \phi, \rho \rangle \Downarrow \langle v, \xi'\{x \mapsto v\}, \phi, \rho' \rangle} \text{ (GLOBALASSIGN)}$$

$$\frac{\langle e_1, \xi, \phi, \rho \rangle \Downarrow \langle v_1, \xi', \phi, \rho' \rangle \qquad v_1 \neq 0 \qquad \langle e_2, \xi', \phi, \rho' \rangle \Downarrow \langle v_2, \xi'', \phi, \rho'' \rangle}{\langle \text{IF}(e_1, e_2, e_3), \xi, \phi, \rho \rangle \Downarrow \langle v_2, \xi'', \phi, \rho'' \rangle} \text{ (IFTRUE)}$$

$$\frac{\langle e_1, \xi, \phi, \rho \rangle \Downarrow \langle v_1, \xi', \phi, \rho' \rangle \qquad v_1 = 0 \qquad \langle e_3, \xi', \phi, \rho' \rangle \Downarrow \langle v_3, \xi'', \phi, \rho'' \rangle}{\langle \text{IF}(e_1, e_2, e_3), \xi, \phi, \rho \rangle \Downarrow \langle v_3, \xi'', \phi, \rho'' \rangle} \text{ (IFFALSE)}$$

Part A: Talking Operational Semantics (20%)

Part B: Operational Semantics and Language Design (35%)

Part C: Derivatives, Proofs, and Metatheory (45%)