Problem Set 5

Problem 1: State

Do exercise 8.9 (a) and (b) on page 296 of the course notes.

Problem 2: More State

a. Give a translation of call-by-value FLAVARK! into call-by-value FLK!. You do not need to translate rec.


Problem 3: Control

Sam Antix decides to add a new exception handling primitive to FL! + {raise, trap}. He adds the following expression to the grammar of FL! + {raise, trap}:

\[(\text{handle } \text{I } E_h \text{ E}_b)\]

Informally, Sam’s new expression is similar to

\[(\text{trap } \text{I } E_h \text{ E}_b).\]

Both expressions evaluate \(E_h\) to a handler procedure and dynamically install the procedure as a handler for exception \(I\). Then the body expression \(E_b\) is evaluated. If \(E_b\) returns normally, then the installed handler is removed, and the value returned is the value of \(E_b\).

However, if the evaluation of \(E_b\) reaches an expression

\[(\text{raise } \text{I } E),\]

then \(E\) is evaluated and the handler procedure is applied to the resulting value. With \text{trap}, this application is evaluated at the point of the \text{raise} expression. But with \text{handle}, the application is evaluated at the point of the \text{handle} expression. In particular, both the dynamic environment and continuation are inherited from the \text{handle} expression, not the \text{raise} expression.

Here are a few example evaluations involving \text{handle}:

\[
\begin{align*}
(\text{handle} \ a \ (\lambda \ x \ (+ \ 4000 \ x))) \\
(\text{handle} \ b \ (\lambda \ x \ (+ \ 300 \ (\text{raise} \ a \ (+ \ x \ 4))))))) \\
(\text{handle} \ a \ (\lambda \ x \ (+ \ 20 \ x)) \\
(+) \ (\text{raise} \ b \ 2)))))) \\
\Rightarrow \ 4006
\end{align*}
\]

\[
(\text{handle} \ a \ (\lambda \ x \ (* \ 10)) \\
(+) \ (\text{raise} \ a \ (+ \ 2 \ (\text{raise} \ a \ 4)))))) \\
\Rightarrow \ 40
\]
a. Extend the denotational semantics of call-by-value FLK! + \{\text{raise}, \text{trap}\} with a valuation clause for \text{handle}.

b. Give a desugaring of \text{handle} into FL! + \{\text{raise}, \text{trap}, \text{label}, \text{jump}\}.