CS 221 **Programming Languages** **Handout 3**
Fall 2005 **Nov 23 , 2005**

Landin's SECD Machine

$$
\begin{array}{rrcl}
\text{States} & s & ::= & \texttt{nil} \mid (S, E, C) :: s \\
\text{Stacks} & S & ::= & \texttt{nil} \mid v :: S \quad \text{(value list)} \\
\text{Control} & C & ::= & \texttt{nil} \mid ce :: C \\
\text{Control element} & ce & ::= & e \mid \texttt{Prim}(op) \mid \texttt{App} \mid \texttt{If}
\end{array}
$$

Initial State (for expression e): $(nil, empty, e :: nil) :: nil$

Final States: $(v :: nil, empty, nil) :: nil$, where v is the result value.

Analyze

$$(S, E, op(e_1, e_2) :: C) :: D \quad \mapsto \quad (S, E, e_1 :: e_2 :: \texttt{Prim}(op) :: C) :: D \tag{1}$$

$$(S, E, \texttt{apply}(e_1, e_2) :: C) :: D \quad \mapsto \quad (S, E, e_1 :: e_2 :: \texttt{App} :: C) :: D \tag{2}$$

$$(S, E, \texttt{if}(e, e_1, e_2) :: C) :: D \quad \mapsto \quad (S, E, e :: \texttt{If} :: e_1 :: e_2 :: C) :: D \tag{3}$$

Value Expressions

$$(S, E, n :: C) :: D \quad \mapsto \quad (n :: S, E, C) :: D \tag{4}$$

$$(S, E, b :: C) :: D \quad \mapsto \quad (b :: S, E, C) :: D \tag{5}$$

$$(S, E, x :: C) :: D \quad \mapsto \quad (E(x) :: S, E, C) :: D \tag{6}$$

$$(S, E, (\texttt{fun}\ f(x)\ \texttt{is}\ e) :: C) :: D \quad \mapsto \quad ([\texttt{fun}\ f(x)\ \texttt{is}\ e; E] :: S, E, C) :: D \tag{7}$$

Function Call

$$
\begin{array}{l}
(v_2 :: v_1 :: S, E, \texttt{App} :: C) :: D \ \mapsto \\
\quad (nil, E'[f \mapsto v_1][x \mapsto v_2], e :: nil) :: (S, E, C) :: D
\end{array} \tag{8}
$$

where $v_1 = [\texttt{fun}\ f(x)\ \texttt{is}\ e; E']$.

Function Return

$$(v :: S, E, nil) :: (S', E', C') :: D \quad \mapsto \quad (v :: S', E', C') :: D \tag{9}$$

Consume values

$$(v_2 :: v_1 :: S, E, \texttt{Prim}(op) :: C) :: D \quad \mapsto \quad ((v_1 op v_2) :: S, E, C) :: D \tag{10}$$

$$(true :: S, E, \texttt{If} :: e_1 :: e_2 :: C) :: D \quad \mapsto \quad (S, E, e_1 :: C) :: D \tag{11}$$

$$(false :: S, E, \texttt{If} :: e_1 :: e_2 :: C) :: D \quad \mapsto \quad (S, E, e_2 :: C) :: D \tag{12}$$