Value Conversion in IL1 after Lambda Hoisting

Lee Gao (lg342)

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Given the closure-conversion and then hoisted restricted language IL1 detailed below

$$v ::= n \mid x \mid \mathsf{halt}$$
$$e ::= v \mid v_0 + v_1 \mid (v_0, \cdots, v_n) \mid \pi_n v$$
$$c ::= \mathsf{let}\, x = e \,\mathsf{in}\, c \mid v_0\ v_1\ v_2 \mid v_0\ v_1$$

we want to "lower" numbers and halt into expressions (as Val used in bindings only) and leave only variables as values, so in effect our language will now look like

$$v ::= x$$
$$e ::= v \mid \mathsf{val}(n) \mid \mathsf{val}(\mathsf{halt})v_0 + v_1 \mid (v_0, \cdots, v_n) \mid \pi_n v$$
$$c ::= \mathsf{let}\, x = e \,\mathsf{in}\, c \mid v_0\ v_1\ v_2 \mid v_0\ v_1$$

We want to define a set of "lowering" translation $\mathcal{LV}[\![v]\!], \mathcal{LE}[\![e]\!], \mathcal{LC}[\![c]\!]$ that binds all non-variable values (integers and halts) into their own variables. Therefore, we need to have both the value and the expressions translation be able to be abstracted as bindings.

$$\mathcal{LV}[\![v]\!] : (\mathsf{var} \times e)\mathsf{list} \times \mathsf{var}$$
$$\mathcal{LE}[\![e]\!] : (\mathsf{var} \times e)\mathsf{list} \times \mathsf{e}$$
$$\mathcal{LC}[\![c]\!] : c$$

We will use the notation

$$\mathsf{let}\, x_i = e_i \,\mathsf{in}\, x$$

to mean

$$([(x_i, e_i); \cdots (x_n, e_n)], x)$$

and respective syntax sugary for expressions.

1 Values

$$\mathcal{LV}[\![n]\!] = \mathsf{let}\, x = n \,\mathsf{in}\, x$$
$$\mathcal{LV}[\![x]\!] = ([], x)$$
$$\mathcal{LV}[\![\mathsf{halt}]\!] = \mathsf{let}\, x = \mathsf{halt} \,\mathsf{in}\, x$$

2 Expressions

Notice immediately that we only ever translate e in the context of let expressions, so we don't have to translate the case of just a value.

$$\mathcal{LE}[\![v_0 + v_1]\!] = \mathsf{let}(l_0, x_0) = \mathcal{LV}[\![v_0]\!] \mathsf{ in } \mathsf{let}(l_1, x_1) = \mathcal{LV}[\![v_1]\!] \mathsf{ in } (l_0 \cup l_1, x_0 + x_1)$$

$$\mathcal{LE}[\![(v_0, \cdots, v_n)]\!] = \mathsf{let}(l_0, x_0) = \mathcal{LV}[\![v_0]\!] \mathsf{ in } \cdots \mathsf{let}(l_n, x_n) = \mathcal{LV}[\![v_n]\!] \mathsf{ in } (\bigcup l_k, (x_1, \cdots, x_n))$$

$$\mathcal{LE}[\![\pi_n v]\!] = \mathsf{let}(l, x) = \mathcal{LV}[\![v]\!] \mathsf{ in } (l, \pi_n x)$$

3 Commands

$$\mathcal{LC}[\![\mathsf{let } x = e \mathsf{ in } c]\!] = \mathsf{let}(x_i = e_i, e') = \mathcal{LE}[\![e]\!] \mathsf{ in } \qquad \underbrace{\mathsf{let } x_i = e_i, x = e' \mathsf{ in } \mathcal{LC}[\![c]\!]}_{\text{this is the actual command returned}}$$

$$\mathcal{LC}[\![v_0 \ v_1]\!] = \mathsf{let}(x_i = e_i, x) = \mathcal{LV}[\![v_0]\!], (y_j = e'_j, y) = \mathcal{LV}[\![v_1]\!] \mathsf{ in } \qquad \mathsf{let } x_i = e_i, y_j = e'_j \mathsf{ in } x \ y$$

and without loss of generality, the same applies to the 3 argument case.