Lazifying case constants

Lars Hupel

September 13, 2023

Abstract

Isabelle’s code generator performs various adaptations for target languages. Among others, case statements are printed as match expressions. Internally, this is a sophisticated procedure, because in HOL, case statements are represented as nested calls to the case combinators as generated by the datatype package. Furthermore, the procedure relies on laziness of match expressions in the target language, i.e., that branches guarded by patterns that fail to match are not evaluated. Similarly, if-then-else is printed to the corresponding construct in the target language. This entry provides tooling to replace these special cases in the code generator by ignoring these target language features, instead printing case expressions and if-then-else as functions.

1 Introduction

theory Lazy-Case
imports Main
keywords lazify :: thy-decl
begin

Importing this theory adds a preprocessing step to the code generator: All case constants (and If) are replaced by “lazy” versions; i.e., new constants that evaluate the cases lazily. For example, the type of case-list is 'a ⇒ ('b ⇒ 'b list ⇒ 'a) ⇒ 'b list ⇒ 'a. A new constant is created with the type (unit ⇒ 'a) ⇒ ('b ⇒ 'b list ⇒ 'a) ⇒ 'b list ⇒ 'a. All fully-applied occurrences of the standard case constants are rewritten (using the [code-unfold] attribute).

The motivation for doing this is twofold:

1. Reconstructing match expressions is complicated. For existing target languages, this theory reduces the amount of code that has to be trusted in the code generator, because the transformation goes through the kernel.

2. It lays the groundwork to support targets that do not have syntactic constructs for case expressions or that cannot be used for some reason, or targets where lazy evaluation of branching constructs is not given.
The obvious downside is that this construction will usually degrade performance of generated code. To some extent, an optimising compiler that performs inlining can alleviate that.

2 Setup

If is just an alias for case-bool.

lemma [code-unfold]: HOL.If P t f = case-bool t f P by simp

ML-file lazy-case.ML
setup Lazy-Case.setup

3 Usage

theory Test-Lazy-Case
imports Lazy-Case
begin

This entry provides a datatype plugin and a separate command. The plugin runs by default on all defined datatypes, but it can be disabled individually:

datatype (plugins del: lazy-case) 'a tree = Node 'a 'a tree list

category begin

The lazify command can be used to add lazy constants if the plugin has been disabled during datatype definition.

lazify tree

end

Nested and mutual recursion are supported.

datatype 'a mlist1 = MNil1 | MCons1 'a 'a mlist2 and 'a mlist2 = MNil2 | MCons2 'a 'a mlist1

Records are supported.

record meep =
  x1 :: nat
  x2 :: int

4 Examples

definition test where
\[ \text{test } x \leftrightarrow (\text{if } x \text{ then } \text{True} \text{ else } \text{False}) \]

\textbf{definition} \textit{test'} where
\[ \text{test'} = \text{case-bool } \text{True} \text{ False} \]

\textbf{definition} \textit{test'’} where
\[ \text{test'}'xs = \text{(case xs of } [] \Rightarrow \text{False } | \cdot \Rightarrow \text{True}) \]

\textbf{fun} \textit{fac :: nat } ⇒ \textit{nat} where
\[ \text{fac } n = (\text{if } n \leq 1 \text{ then } 1 \text{ else } n \ast \text{fac } (n - 1)) \]

\textbf{lemma} \textit{map-tree[code]}:
\[ \text{map-tree } f t = \text{(case } t \text{ of } \text{Node } ⇒ \text{Node } | \text{Fork } x ts ⇒ \text{Fork } (f x) (\text{map } \text{map-tree } f) ts) \]
\by\ (\text{induction } t) \text{ auto} 

The generated code uses neither target-language \textit{if-then-else} nor match expressions.

\textbf{export-code} \textit{test test' test'’ fac map-tree in SML}

\textbf{end}