Veriopt Theories

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1 Optization DSLs

theory *Markup*
imports *Semantics.IRTreeEval Snippets.Snipping*
begin

datatype *'a Rewrite* =
Transform 'a 'a (- ⟼ - *10*) |
Conditional 'a 'a bool (- ⟼ - *when* - *70*) |
Sequential 'a Rewrite 'a Rewrite |
Transitive 'a Rewrite

datatype *'a ExtraNotation* =
ConditionalNotation 'a 'a 'a (- *?* - : -) |
EqualsNotation 'a 'a (- *eq* -) |
ConstantNotation 'a (*const* - *120*) |
TrueNotation (*true*) |
FalseNotation (*false*) |
ExclusiveOr 'a 'a (- ⊕ -) |
LogicNegationNotation 'a (!-) |
ShortCircuitOr 'a 'a (- || -)

definition *word* :: (*'a*::*len*) *word* ⇒ *'a word* **where**
word x = *x*

ML-file ‹*markup.ML*›

ML ‹
structure IRExprTranslator : *DSL-TRANSLATION* =
struct
fun markup DSL-Tokens.Add = @{*term BinaryExpr*} $ @{*term BinAdd*}
| *markup DSL-Tokens.Sub* = @{*term BinaryExpr*} $ @{*term BinSub*}

```
  | markup DSL-Tokens.Mul = @{term BinaryExpr} $ @{term BinMul}
  | markup DSL-Tokens.And = @{term BinaryExpr} $ @{term BinAnd}
  | markup DSL-Tokens.Or = @{term BinaryExpr} $ @{term BinOr}
  | markup DSL-Tokens.Xor = @{term BinaryExpr} $ @{term BinXor}
  | markup DSL-Tokens.ShortCircuitOr = @{term BinaryExpr} $ @{term Bin-
ShortCircuitOr}
  | markup DSL-Tokens.Abs = @{term UnaryExpr} $ @{term UnaryAbs}
 | markup DSL-Tokens.Less = @{term BinaryExpr} $ @{term BinIntegerLessThan}
 | markup DSL-Tokens.Equals = @{term BinaryExpr} $ @{term BinIntegerEquals}
  | markup DSL-Tokens.Not = @{term UnaryExpr} $ @{term UnaryNot}
  | markup DSL-Tokens.Negate = @{term UnaryExpr} $ @{term UnaryNeg}
  | markup DSL-Tokens.LogicNegate = @{term UnaryExpr} $ @{term UnaryLog-
icNegation}
  | markup DSL-Tokens.LeftShift = @{term BinaryExpr} $ @{term BinLeftShift}
  | markup DSL-Tokens.RightShift = @{term BinaryExpr} $ @{term BinRight-
Shift}
  | markup DSL-Tokens.UnsignedRightShift = @{term BinaryExpr} $ @{term Bin-
URightShift}
  | markup DSL-Tokens.Conditional = @{term ConditionalExpr}
  | markup DSL-Tokens.Constant = @{term ConstantExpr}
  | markup DSL-Tokens.TrueConstant = @{term ConstantExpr (IntVal32 1)}
  | markup DSL-Tokens.FalseConstant = @{term ConstantExpr (IntVal32 0)}
end

structure IntValTranslator : DSL-TRANSLATION =
struct
fun markup DSL-Tokens.Add = @{term intval-add}
  | markup DSL-Tokens.Sub = @{term intval-sub}
  | markup DSL-Tokens.Mul = @{term intval-mul}
  | markup DSL-Tokens.And = @{term intval-and}
  | markup DSL-Tokens.Or = @{term intval-or}
  | markup DSL-Tokens.ShortCircuitOr = @{term intval-short-circuit-or}
  | markup DSL-Tokens.Xor = @{term intval-xor}
  | markup DSL-Tokens.Abs = @{term intval-abs}
  | markup DSL-Tokens.Less = @{term intval-less-than}
  | markup DSL-Tokens.Equals = @{term intval-equals}
  | markup DSL-Tokens.Not = @{term intval-not}
  | markup DSL-Tokens.Negate = @{term intval-negate}
  | markup DSL-Tokens.LogicNegate = @{term intval-logic-negation}
  | markup DSL-Tokens.LeftShift = @{term intval-left-shift}
  | markup DSL-Tokens.RightShift = @{term intval-right-shift}
  | markup DSL-Tokens.UnsignedRightShift = @{term intval-uright-shift}
  | markup DSL-Tokens.Conditional = @{term intval-conditional}
  | markup DSL-Tokens.Constant = @{term IntVal32}
  | markup DSL-Tokens.TrueConstant = @{term IntVal32 1}
  | markup DSL-Tokens.FalseConstant = @{term IntVal32 0}
end

structure WordTranslator : DSL-TRANSLATION =
```

```
struct
fun markup DSL-Tokens.Add = @{term plus}
  | markup DSL-Tokens.Sub = @{term minus}
  | markup DSL-Tokens.Mul = @{term times}
 | markup DSL-Tokens.And = @{term Bit-Operations.semiring-bit-operations-class.and}
  | markup DSL-Tokens.Or = @{term or}
  | markup DSL-Tokens.Xor = @{term xor}
  | markup DSL-Tokens.Abs = @{term abs}
  | markup DSL-Tokens.Less = @{term less}
  | markup DSL-Tokens.Equals = @{term HOL.eq}
  | markup DSL-Tokens.Not = @{term not}
  | markup DSL-Tokens.Negate = @{term uminus}
  | markup DSL-Tokens.LogicNegate = @{term logic-negate}
  | markup DSL-Tokens.LeftShift = @{term shiftl}
  | markup DSL-Tokens.RightShift = @{term signed-shiftr}
  | markup DSL-Tokens.UnsignedRightShift = @{term shiftr}
  | markup DSL-Tokens.Constant = @{term word}
  | markup DSL-Tokens.TrueConstant = @{term 1}
  | markup DSL-Tokens.FalseConstant = @{term 0}
end

structure IRExprMarkup = DSL-Markup(IRExprTranslator);
structure IntValMarkup = DSL-Markup(IntValTranslator);
structure WordMarkup = DSL-Markup(WordTranslator);
›
```

ir expression translation

syntax -*expandExpr* :: *term* ⇒ *term* (*exp*[-])
parse-translation ‹ [(@{*syntax-const* -*expandExpr*} , *IRExprMarkup.markup-expr* [])] ›

value expression translation

syntax -*expandIntVal* :: *term* ⇒ *term* (*val*[-])
parse-translation ‹ [(@{*syntax-const* -*expandIntVal*} , *IntValMarkup.markup-expr* [])] ›

word expression translation

syntax -*expandWord* :: *term* ⇒ *term* (*bin*[-])
parse-translation ‹ [(@{*syntax-const* -*expandWord*} , *WordMarkup.markup-expr* [])] ›

ir expression example

value *exp*[$(e_1 < e_2)$ *?* e_1 : e_2]

ConditionalExpr (*BinaryExpr BinIntegerLessThan* e_1 e_2) e_1 e_2

value expression example

value *val*[$(e_1 < e_2)$ *?* e_1 : e_2]

intval-conditional (*intval-less-than* e_1 e_2) e_1 e_2

value *exp*[$((e_1 - e_2) + (const\ (IntVal32\ 0)) + e_2) \longmapsto e_1$ *when True*]
value *val*[$((e_1 - e_2) + (const\ 0) + e_2) \longmapsto e_1$ *when True*]

word expression example

value *bin*[x & y | z]

intval-conditional (*intval-less-than* e_1 e_2) e_1 e_2

value *bin*[$-x$]
value *val*[$-x$]
value *exp*[$-x$]

value *bin*[!x]
value *val*[!x]
value *exp*[!x]

value *bin*[$\neg x$]
value *val*[$\neg x$]
value *exp*[$\neg x$]

value *bin*[$^\sim x$]
value *val*[$^\sim x$]
value *exp*[$^\sim x$]

value $^\sim x$

end
theory *Phase*
  imports *Main*
begin

ML-file *map.ML*
ML-file *phase.ML*

end

1.1 Canonicalization DSL

theory *Canonicalization*
  imports
    Markup
    Phase
    HOL−Eisbach.Eisbach
  keywords
    phase :: *thy-decl* **and**
    terminating :: *quasi-command* **and**
    print-phases :: *diag* **and**
    optimization :: *thy-goal-defn*
begin

ML ‹
datatype 'a Rewrite =
  *Transform of 'a * 'a |*
  *Conditional of 'a * 'a * term |*
  *Sequential of 'a Rewrite * 'a Rewrite |*
  Transitive of 'a Rewrite

type rewrite = {name: string, rewrite: term Rewrite}

structure RewriteRule : Rule =
struct
type T = rewrite;

fun pretty-rewrite ctxt (Transform (from, to)) =
      Pretty.block [
        Syntax.pretty-term ctxt from,
        Pretty.str ↦ ,
        Syntax.pretty-term ctxt to
      ]
  | pretty-rewrite ctxt (Conditional (from, to, cond)) =
      Pretty.block [
        Syntax.pretty-term ctxt from,
        Pretty.str ↦ ,
        Syntax.pretty-term ctxt to,
        Pretty.str when ,
        Syntax.pretty-term ctxt cond
      ]
  | pretty-rewrite - - = Pretty.str not implemented

fun pretty ctxt t =
  Pretty.block [
    Pretty.str ((#name t) ^:),
    pretty-rewrite ctxt (#rewrite t)
  ]
end

```
structure RewritePhase = DSL-Phase(RewriteRule);

val - =
  Outer-Syntax.command command-keyword ‹phase› enter an optimization phase
    (Parse.binding --| Parse.$$$ terminating -- Parse.const --| Parse.begin
      >> (Toplevel.begin-main-target true o RewritePhase.setup));

fun print-phases ctxt =
  let
    val thy = Proof-Context.theory-of ctxt;
    fun print phase = RewritePhase.pretty phase ctxt
  in
    map print (RewritePhase.phases thy)
  end

fun print-optimizations thy =
  print-phases thy |> Pretty.writeln-chunks

val - =
  Outer-Syntax.command command-keyword ‹print-phases›
    print debug information for optimizations
    (Scan.succeed
      (Toplevel.keep (print-optimizations o Toplevel.context-of)));
›

ML-file rewrites.ML

fun rewrite-preservation :: IRExpr Rewrite ⇒ bool where
  rewrite-preservation (Transform x y) = (y ≤ x) |
  rewrite-preservation (Conditional x y cond) = (cond ⟶ (y ≤ x)) |
  rewrite-preservation (Sequential x y) = (rewrite-preservation x ∧ rewrite-preservation
y) |
  rewrite-preservation (Transitive x) = rewrite-preservation x

fun rewrite-termination :: IRExpr Rewrite ⇒ (IRExpr ⇒ nat) ⇒ bool where
  rewrite-termination (Transform x y) trm = (trm x > trm y) |
  rewrite-termination (Conditional x y cond) trm = (cond ⟶ (trm x > trm y)) |
  rewrite-termination (Sequential x y) trm = (rewrite-termination x trm ∧ rewrite-termination
y trm) |
  rewrite-termination (Transitive x) trm = rewrite-termination x trm

fun intval :: Value Rewrite ⇒ bool where
  intval (Transform x y) = (x ≠ UndefVal ∧ y ≠ UndefVal ⟶ x = y) |
  intval (Conditional x y cond) = (cond ⟶ (x = y)) |
  intval (Sequential x y) = (intval x ∧ intval y) |
  intval (Transitive x) = intval x

fun size :: IRExpr ⇒ nat where
  size (UnaryExpr op e) = (size e) + 1 |
```

```
  size (BinaryExpr BinAdd x y) = (size x) + ((size y) * 2) |
  size (BinaryExpr op x y) = (size x) + (size y) |
  size (ConditionalExpr cond t f) = (size cond) + (size t) + (size f) + 2 |
  size (ConstantExpr c) = 1 |
  size (ParameterExpr ind s) = 2 |
  size (LeafExpr nid s) = 2 |
  size (ConstantVar c) = 2 |
  size (VariableExpr x s) = 2

method unfold-optimization =
  (unfold rewrite-preservation.simps, unfold rewrite-termination.simps,
    unfold intval.simps,
    rule conjE, simp, simp del: le-expr-def, force?)
  | (unfold rewrite-preservation.simps, unfold rewrite-termination.simps,
    rule conjE, simp, simp del: le-expr-def, force?)

method unfold-size =
  (unfold size.simps, simp del: le-expr-def)?
  | (unfold size.simps)?

print-methods

ML ‹
structure System : RewriteSystem =
struct
val preservation = @{const rewrite-preservation};
val termination = @{const rewrite-termination};
val intval = @{const intval};
end

structure DSL = DSL-Rewrites(System);

val - =
  Outer-Syntax.local-theory-to-proof command-keyword ‹optimization›
    define an optimization and open proof obligation
    (Parse-Spec.thm-name : -- Parse.term
        >> DSL.rewrite-cmd);
›

end
```