

Veriopt Theories

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1 Optization DSLs

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

```
datatype 'a Rewrite =
  Transform 'a 'a (-  $\mapsto$  - 10) |
  Conditional 'a 'a bool (-  $\mapsto$  - 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 (-  $\oplus$  -) |
  LogicNegationNotation 'a (!-) |
  ShortCircuitOr 'a 'a (- || -)
```

```
definition word :: ('a::len) word  $\Rightarrow$  'a word where
  word x = x
```

ML-file $\langle markup.ML \rangle$

```
ML  $\langle$ 
structure IRExpTranslator : 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*[($(e_1 - e_2) + (\text{const } (\text{IntVal32 } 0)) + e_2$) $\mapsto e_1$ when True]

value *val*[($(e_1 - e_2) + (\text{const } 0) + e_2$) $\mapsto e_1$ when True]

word expression example

value *bin*[$x \& y \mid z$]

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

value *bin*[$\neg x$]

value *val*[$\neg x$]

value *exp*[$\neg x$]

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 \mapsto ,

Syntax.pretty-term *ctxt* *to*

]

| *pretty-rewrite* *ctxt* (*Conditional* (*from*, *to*, *cond*)) =

Pretty.block [

Syntax.pretty-term *ctxt* *from*,

Pretty.str \mapsto ,

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*) \wedge :),

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 :: IRExp Rewrite  $\Rightarrow$  bool where
  rewrite-preservation (Transform x y) = (y  $\leq$  x) |
  rewrite-preservation (Conditional x y cond) = (cond  $\longrightarrow$  (y  $\leq$  x)) |
  rewrite-preservation (Sequential x y) = (rewrite-preservation x  $\wedge$  rewrite-preservation
  y) |
  rewrite-preservation (Transitive x) = rewrite-preservation x

fun rewrite-termination :: IRExp Rewrite  $\Rightarrow$  (IRExp  $\Rightarrow$  nat)  $\Rightarrow$  bool where
  rewrite-termination (Transform x y) trm = (trm x > trm y) |
  rewrite-termination (Conditional x y cond) trm = (cond  $\longrightarrow$  (trm x > trm y)) |
  rewrite-termination (Sequential x y) trm = (rewrite-termination x trm  $\wedge$  rewrite-termination
  y trm) |
  rewrite-termination (Transitive x) trm = rewrite-termination x trm

fun intval :: Value Rewrite  $\Rightarrow$  bool where
  intval (Transform x y) = (x  $\neq$  UndefVal  $\wedge$  y  $\neq$  UndefVal  $\longrightarrow$  x = y) |
  intval (Conditional x y cond) = (cond  $\longrightarrow$  (x = y)) |
  intval (Sequential x y) = (intval x  $\wedge$  intval y) |
  intval (Transitive x) = intval x

fun size :: IRExp  $\Rightarrow$  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

```