

# Veriopt Theories

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## Contents

<b>1</b>	<b>Optization DSLs</b>	<b>1</b>
1.1	Canonicalization DSL . . . . .	3

## 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)
```

**ML-file** `markup.ML`

```
ML <
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.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 UnaryLogicNegation}
```

```

| markup DSL-Tokens.Negate = @{term UnaryExpr} $ @{term UnaryNeg}
| markup DSL-Tokens.LeftShift = @{term BinaryExpr} $ @{term BinLeftShift}
| markup DSL-Tokens.RightShift = @{term BinaryExpr} $ @{term BinRightShift}
| 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.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-logic-negation}
| markup DSL-Tokens.Negate = @{term intval-negate}
| 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 IRExprMarkup = DSL-Markup(IRExprTranslator);
structure IntValMarkup = DSL-Markup(IntValTranslator);
}

```

*ir expression translation*

```

syntax -expandExpr :: term ⇒ term (exp[-])
parse-translation < [( @{syntax-const -expandExpr} , IREx-
prMarkup.markup-expr)] >

```

*value expression translation*

```

syntax -expandIntVal :: term ⇒ term (val[-])
parse-translation < [( @{syntax-const -expandIntVal} , IntVal-
Markup.markup-expr)] >

```

*ir expression example*

**value** *exp*[(*e*<sub>1</sub> < *e*<sub>2</sub>) ? *e*<sub>1</sub> : *e*<sub>2</sub>]

*ConditionalExpr (BinaryExpr BinIntegerLessThan e<sub>1</sub> e<sub>2</sub>) e<sub>1</sub> e<sub>2</sub>*

*value expression example*

**value** *val*[(*e*<sub>1</sub> < *e*<sub>2</sub>) ? *e*<sub>1</sub> : *e*<sub>2</sub>]

*intval-conditional (intval-less-than e<sub>1</sub> e<sub>2</sub>) e<sub>1</sub> e<sub>2</sub>*

**value** *exp*[(*e*<sub>1</sub> - *e*<sub>2</sub>) + (*const* (*IntVal32* 0)) + *e*<sub>2</sub>] ↦ *e*<sub>1</sub> *when True*

**value** *val*[(*e*<sub>1</sub> - *e*<sub>2</sub>) + (*const* 0) + *e*<sub>2</sub>] ↦ *e*<sub>1</sub> *when True*

**end**

**theory** *Phase*

**imports** *Main*

**begin**

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

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

**end**

## 1.1 Canonicalization DSL

**theory** *Canonicalization*

**imports**

*Markup*

*Phase*

**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) ^ :),
    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

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
```