

# Veriopt Theories

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## 1 Canonicalization Phase

```
theory Common
imports
  OptimizationDSL.Canonicalization
  HOL-Eisbach.Eisbach
begin

fun size :: IRExpr  $\Rightarrow$  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)
| (unfold rewrite-preservation.simps, unfold rewrite-termination.simps,
   rule conjE, simp, simp del: le-expr-def)

end
```

### 1.1 Conditional Expression

```
theory ConditionalPhase
imports
```

```

    Common
    Proofs.StampEvalThms
begin

phase Conditional
  terminating size
begin

lemma negates: is-IntVal32 e  $\vee$  is-IntVal64 e  $\implies$  val-to-bool (val[e])  $\equiv \neg$ (val-to-bool
(val[ $\neg$ e]))
  by (smt (verit, best) Value.disc(1) Value.disc(10) Value.disc(4) Value.disc(5)
Value.disc(6) Value.disc(9) intval-logic-negation.elims val-to-bool.simps(1) val-to-bool.simps(2)
zero-neq-one)

optimization negate-condition: ( $\neg$ e) ? x : y  $\mapsto$  (e ? y : x)
  apply unfold-optimization apply simp using negates
  using ConditionalExprE UnaryExprE intval-logic-negation.elims unary-eval.simps(4)
val-to-bool.simps(1) val-to-bool.simps(2) zero-neq-one
  apply (smt (verit) ConditionalExpr)
  unfolding size.simps by simp

optimization const-true: (true ? x : y)  $\mapsto$  x
  apply unfold-optimization
  apply force
  unfolding size.simps by simp

optimization const-false: (false ? x : y)  $\mapsto$  y
  apply unfold-optimization
  apply force
  unfolding size.simps by simp

optimization equal-branches: (e ? x : x)  $\mapsto$  x
  apply unfold-optimization
  apply force
  unfolding size.simps by auto

definition wff-stamps :: bool where
  wff-stamps = ( $\forall$  m p expr val . ([m,p]  $\vdash$  expr  $\mapsto$  val)  $\longrightarrow$  valid-value val (stamp-expr
expr))

definition wf-stamp :: IRExp  $\Rightarrow$  bool where
  wf-stamp e = ( $\forall$  m p v . ([m, p]  $\vdash$  e  $\mapsto$  v)  $\longrightarrow$  valid-value v (stamp-expr e))

optimization condition-bounds-x: ((u < v) ? x : y)  $\mapsto$  x
  when (stamp-under (stamp-expr u) (stamp-expr v)  $\wedge$  wf-stamp u  $\wedge$  wf-stamp v)
  apply unfold-optimization
  using stamp-under-semantics
  using wf-stamp-def

```

```

apply (smt (verit, best) ConditionalExprE le-expr-def stamp-under.simps)
unfolding size.simps by simp

optimization condition-bounds-y: ((x < y) ? x : y)  $\mapsto$  y
  when (stamp-under (stamp-expr y) (stamp-expr x)  $\wedge$  wf-stamp x  $\wedge$  wf-stamp y)
  apply unfold-optimization
  using stamp-under-semantics-inversed
  using wf-stamp-def
  apply (smt (verit, best) ConditionalExprE le-expr-def stamp-under.simps)
  unfolding size.simps by simp

optimization b[intval]: ((x eq y) ? x : y)  $\mapsto$  y
  apply unfold-optimization
  apply (smt (z3) bool-to-val.simps(2) intval-equals.elims val-to-bool.simps(1)
    val-to-bool.simps(3))
  unfolding intval.simps
  apply (smt (z3) BinaryExprE ConditionalExprE Value.inject(1) Value.inject(2)
    bin-eval.simps(10) bool-to-val.simps(2) evalDet intval-equals.simps(1) intval-equals.simps(10)
    intval-equals.simps(12) intval-equals.simps(15) intval-equals.simps(16) intval-equals.simps(2)
    intval-equals.simps(5) intval-equals.simps(8) intval-equals.simps(9) le-expr-def val-to-bool.cases
    val-to-bool.elims(2))
  unfolding size.simps by auto

end

end

```