Value Numbering (Global)

Notation

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Basic Idea

If $x_1 \equiv x_2$ and $y_1 \equiv y_2$, then $x_1 \; op \; y_1 \equiv x_2 \; op \; y_2$.

Problem: When does congruence hold?

a = b;
a = c;
a = d;

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Solution: SSA form

a_1 = b;
a_2 = c;
a_3 = d;

Value Numbering (Global)

$a_1 = b;$
$a_2 = c;$
$a_3 = d;$

Desired property

$VN(x) = VN(y) \implies x = y$ at every program point p dominated by the (unique) defs of x and y.

Value Numbering (Global)

Congruent Expressions

$x \equiv x$	for all variables x.
$c_1 \equiv c_2$	if c_1 and c_2 are constants and $c_1 = c_2$.
$x_1\ op_1\ x_2 \equiv y_1\ op_2\ y_2$	if $op_1 = op_2$, $x_1 \equiv y_1$, and $x_2 \equiv y_2$.
$\phi_1(x_1, \ldots, x_n) \equiv \phi_2(y_1, \ldots, y_n)$	if ϕ_1 and ϕ_2 are in the same basic block, and $\forall i. x_i \equiv y_i$.

Pessimistic vs. Optimistic Value Numbering

Pessimistic approach

1. Initially assume all expressions are not congruent.
2. Merge sets of expressions determined to be congruent.

Optimistic approach

1. Initially assume all expressions are congruent.
2. Split sets of expressions determined to not be congruent.

Optimistic Algorithm

Algorithm $\mathrm{GVN}()$:

for all operators *op* (including ϕ operators) **do**
create new partition p
for all assignments $x = y_1$ *op* y_2 **do**
add x to p
add p to worklist
while worklist not empty **do**
remove some partition p from worklist
for all x, q, i such that $x \in q$ and i'th operand of x in p **do**
if $\exists y \in q$ st i'th operand of y not in p **then**
create new partition r
for all $y \in q$ st i'th operand of y not in p **do**
move y from q to r
add q and r to worklist