Assignment 2: Simple Constant Propagation

Optimizing Compilers – WT 2012

Deadline: December 5th 2012

1 Simple Constant Propagation

Constant propagation finds for each location in the program, an assignment of program variables to numerical constants, given that a variable has a constant value at the location while executing the program. Constant values can be literals in the program or result of an arithmetic operation on constant values. The data-flow analysis in this assignment calculates and propagates constants for variables along the control flow graph.

The following example depicts a simple intra-procedural constant propagation run for the WHILE language. Unassigned variables are marked as being unknown:

	ℓ	$\text{CP}_\circ(\ell)$	$\text{CP}_\bullet(\ell)$
`[a := 2]`^{1}`;`	1	$\{\}$	$\{\mathtt{a} \mapsto 2\}$
`[b := 7 + a]`^{2}`;`	2	$\{\mathtt{a} \mapsto 2\}$	$\{\mathtt{a} \mapsto 2, \mathtt{b} \mapsto 9\}$
`if [b < c]`^{3} `then`	3	$\{\mathtt{a} \mapsto 2, \mathtt{b} \mapsto 9\}$	$\{\mathtt{a} \mapsto 2, \mathtt{b} \mapsto 9\}$
`  [b := b - 3]`^{4}`;`	4	$\{\mathtt{a} \mapsto 2, \mathtt{b} \mapsto 9\}$	$\{\mathtt{a} \mapsto 2, \mathtt{b} \mapsto 6\}$
`else`			
`  [skip]`^{5}`;`	5	$\{\mathtt{a} \mapsto 2, \mathtt{b} \mapsto 9\}$	$\{\mathtt{a} \mapsto 2, \mathtt{b} \mapsto 9\}$
`[a := a + 7]`^{6}`;`	6	$\{\mathtt{a} \mapsto 2\}$	$\{\mathtt{a} \mapsto 9\}$

Specify the analysis and think of some additional restrictions/features for/of the constant propagation as exemplified above:

(a) The analysis described above calculates constants for expressions only if all operands are constant values. Think of additional rules/patterns for arithmetic expressions that allow to infer a value as being constant, even if the operands are not exclusively constant values.

(b) Prove that the simple constant propagation is not a distributive data-flow analysis. It suffices to find a transfer-function f_ℓ as counterexample to $f_\ell(l_1 \sqcup l_2) = f_\ell(l_1) \sqcup f_\ell(l_2)$.

(c) Give a short (counter-) example program (C or WHILE) where the analysis fails to infer a constant value, even though the calculated value is actually constant.

2 Simple Constant Propagation – Implementation

Specify your analysis and the additional rules that you found using `www.program-analysis.com`. You can use the already available analysis as starting point. Refine the analysis to apply the optimizations from (a), try to replay all your examples.

3 Deadline

Send your solution via email to jakob@complang.tuwien.ac.at, subject line OC-ASGN2-studentid containing your analysis specification and equations until the 2nd of December, 2012. Your submission should include all solutions to the exercises (text in pdf format), together with examples and short explanations of your solutions.