

# Written Assignment 8

## Due April 6, 2006

This assignment asks you to prepare written answers to questions on local and global optimizations. Each of the questions has a short answer. You may discuss this assignment with other students and work on the problems together. However, your write-up should be your own individual work. *Please write the name of the account you are using for CS164 and your section time on your homework.* Remember that written assignments are to be turned in either in class or in the CS164 homework box in 283 Soda by 11 AM on the due date.

1. Consider the following code:

```
a := b + c
z := a ** 2
x := 0 * b
y := b + c
w := y * y
u := x + 3
v := u + w
```

Assume that only  $v$  and  $z$  are live at the exit of this block. In order, apply the following optimizations to this basic block. Show the result of each transformation.

- algebraic simplification
- common sub-expression elimination
- copy propagation
- constant folding/propagation
- dead code elimination

When you've completed part (e), the resulting program will still not be optimal. What optimizations, in what order, can you apply to optimize the result of (e) further?

2. Consider the following fragment of intermediate code (here  $a \% b$  is  $a \bmod b$ , i.e., the remainder of dividing  $a$  by  $b$ ), and the  $/$  operator is integer division:

```
    if a = 2 goto L3
L0: b := 2
L1: d := a / 2
    c := a % b
    if c = 0 goto L2
    if b >= d goto L3
    b := b + 1
    goto L1
L2: a := a + 1
    goto L0
L3:
```

- Draw a control-flow graph for this program. Place each basic block in a single node. Include the conditionals in the basic blocks.
- Annotate your control-flow graph with the set of variables live before and after each statement, assuming that only  $a$  is live at the entry to L3.
- Describe concisely the function that this program computes?