CPEG 421/621 - Homework 2
Issue Date: Tuesday, 6 March, 2012
Due Date: Tuesday, 20 March, 2012

Instructions

Please write the answer to each problem on one sheet of paper. Be as concise and clear as you can. Although we accept hand written answers, we encourage you to hand in print-out solutions or email your solutions to `aron+ta@udel.edu` and `szuckerm@eecis.udel.edu`. If you do hand in hand-written solutions, please make sure the writing is clearly readable. To avoid misplacement of various components of your assignment, make sure that all answer sheets are stapled together. You may discuss the problems with your classmates, but all solutions must be derived independently.

Problem 1

Consider the program in Figure 1:

a. Construct the CFG for the program example.

b. Is this example already in single static assignment (SSA) form?

c. If your answer to the above question is "no", please convert that code into SSA form (insert notes where necessary and then perform renaming upon all real variables and operands.) You can explain your answer using a CFG.

```
1  I = 1;
2  J = 1;
3  K = 1;
4  L = 1;
5  do {
6       if(P)
7       {
8            J = I;
9            if(Q)
10           {
11             L = 2;
12           }
13           K = K + 1;
14      }
15      else
16      {
17           K = K + 2;
18      }
19
20      print (I, J, K, L);
21      do {
22           if(R)
23           {
24             L = L + 3;
25           }
26           else
27           {
28             L = L + 4;
29           }
30      } while (S);
31      I = I + 2;
32 } while (T);
```

Figure 1: A program example.

Problem 2

Consider the program in Figure 2:
(Note: The M[] notation below means to read from memory)

a. Draw a dominator tree.

b. Calculate dominance frontiers.

c. Insert ϕ-functions.

d. Add subscripts to the variables.

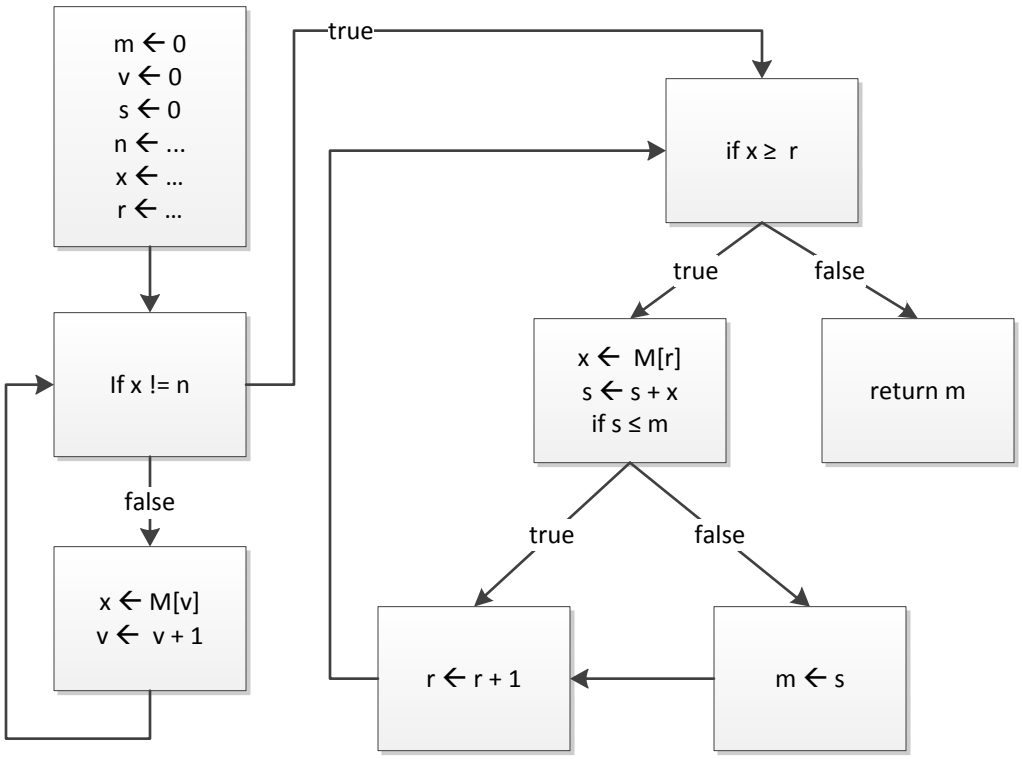

Figure 2: An SSA example.

Problem 3

A real peephole optimizer must deal with control flow operations, including conditional branches, jumps, and labeled statements.

a. What should a peephole optimizer do when it brings a conditional branch into the operation window?

b. Is the situation different when it encounters a jump?

c. What happens with the labeled operation.

Problem 4

The point at which a new abstract value of a variable v is born is called the birth point of the abstract value of v.

a. Is the entry node of a program control flow graph a birth point?

b. Suppose p is a birth point (p $\neq$ entry) of a variable. Is p necessarily a join point of the CFG?

c. Suppose p is a join point. Is p necessarily a birth point?

d. For the above questions, if your answer is "no", give a counter-example.