ECE 468
Problem Set 7: Dataflow analysis

1. Show the results of running a *reaching definition* analysis on the following piece of code: For each line of code, show which definitions reach that line of code by indicating the line number the definition occurred in.

```
    1: x = 4;
    2: y = 7;
L1  3: if (x > c) goto L4
    4:   if (y > 3) goto L2
    5:     a = x + 1;
    6:     y = x + 2;
    7:     goto L3
L2  8:     y = x + 1;
    9:     x = x + 1;
L3 10:   x = x + 1;
   11:   goto L1;
L4 12: halt
```

2. Show the results of running an *available expression* analysis on the code, by indicating which expressions are available at each instruction.

3. In this problem, your goal is to develop a dataflow analysis to find `uninitialized` values. A common error in programs is using a variable that has not yet been defined. Write an analysis that can detect any use of a variable that has not been defined. Do this by tracking, for each variable in a program, whether it is currently defined or not. Hint: think about how this analysis relates to a reaching definition analysis.

   (a) This is a bitvector analysis, where each object of interest in the analysis takes on the value 0 or 1. a) What are the objects of interest in this analysis? b) What does it mean for an object to have value 0? c) What does it mean for the object to have value 1?

   (b) Which direction should this analysis use?

   (c) Give the GEN and KILL sets for this analysis, in terms of **def(s)**, the variables defined in a statement.

(d) Define IN and OUT for this analysis (don't forget which direction your analysis is running: if you're running forward, IN should be defined in terms of a statement's predecessors, and OUT should be defined in terms of IN. If you're running backwards, OUT is defined in terms of a statement's successors, and IN is defined in terms of OUT). Don't forget to think about how your analysis should behave at merge statements.

(e) How should this analysis be initialized? (In a forward analysis, what is IN of the first statement, in a backward analysis, what is OUT of the last statement?