

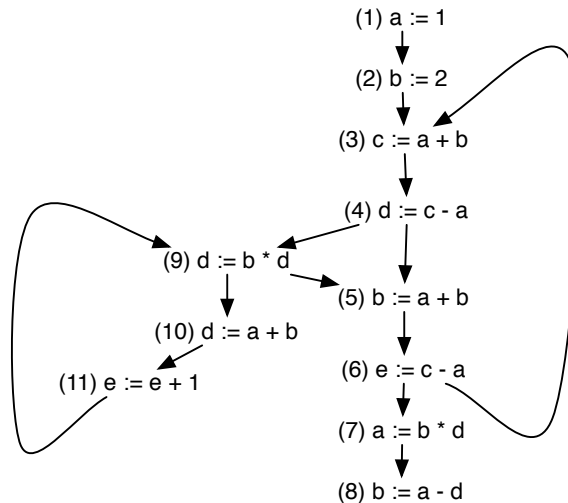
Practice Problems – Data Flow Analysis

This short problem set will help you review your understanding of data flow analysis.

1. Translate the following program into three-address code and draw the control-flow graph for the program. For this problem, the nodes of the control-flow graph should be (maximally large) basic blocks.

```
dx = x1-x0
dy = y1-y0
d = 2*dy - dx
y = y0
for (x = x0+1; x < x1; x++) {
  if (d > 0) {
    y++
    d += 2*dy-2*dx
  }
  else
    d += 2*dy
}
```

2. Consider the following control-flow graph:



Write down the following:

- (a) For each statement, the set of definitions that reach the end of the statement.
 - (b) For each statement, the set of expressions that are available at the end of the statement.
 - (c) For each statement, the set of variables that are live at the beginning of the statement.
 - (d) For each statement, the set of expressions that are very busy at the beginning of the statement.
3. A variable is *definitely assigned* at a program point if it is guaranteed to have been written to (possibly more than once) on all paths from the start of the program to that point. Consider implementing definite assignment analysis as a data flow analysis.
 - (a) Give the direction of the analysis.
 - (b) Define the lattice, and define the meet operation and top.
 - (c) State how to initialize the dataflow facts at the entry or exit nodes, as appropriate.
 - (d) Give the transfer functions for the following statements: $a=b$, $a=b+c$, and $a=a+1$.
 - (e) Are the transfer functions monotonic? Are they distributive? Justify your answer.