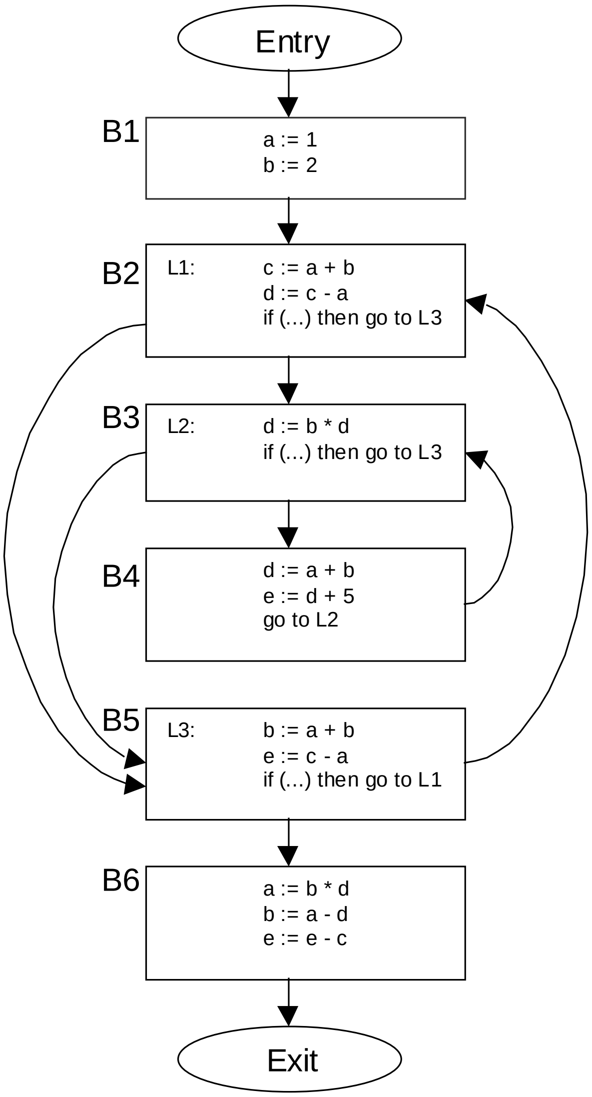
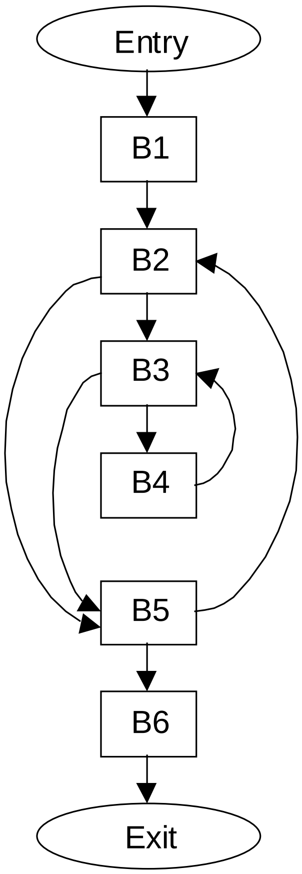
CSE 231 Spring 1998
HW 1 Answers

1. Control Flow Graph

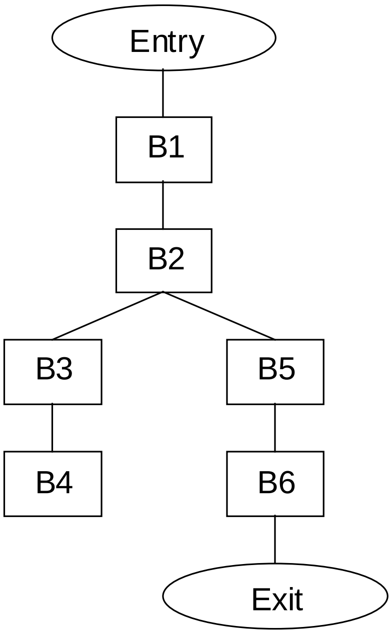


(a) CFG showing instructions in each block

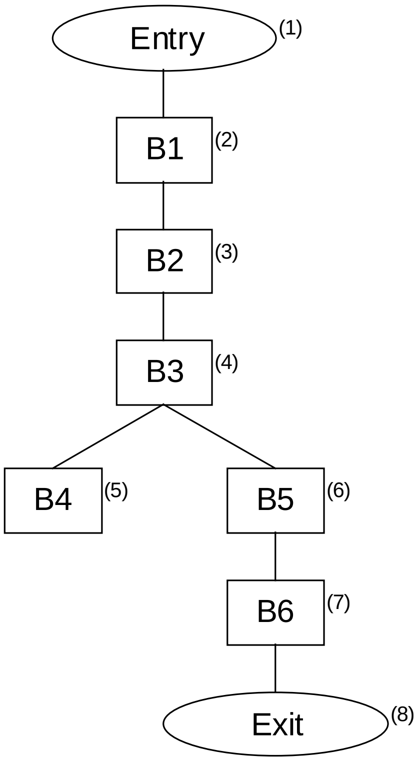


(b) CFG showing basic blocks only

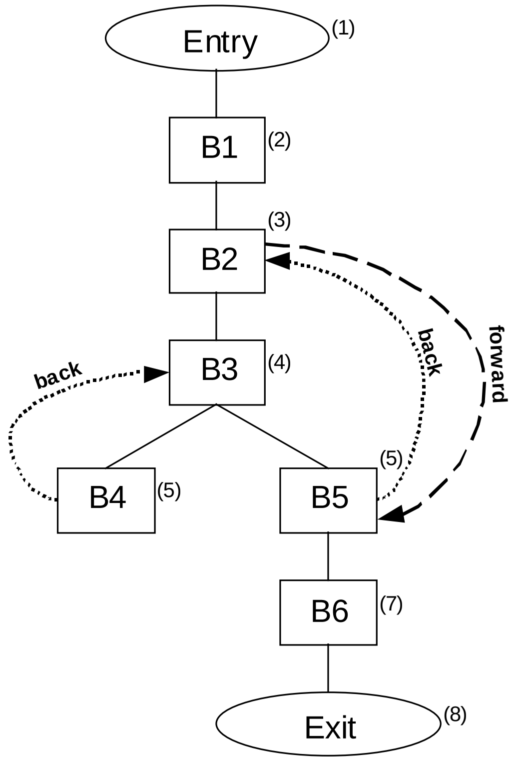
2. Dominator Tree for CFG



3. Depth First Spanning tree of the CFG and preorder numbering of the nodes



4. Back, forward and cross edges for the previous numbering



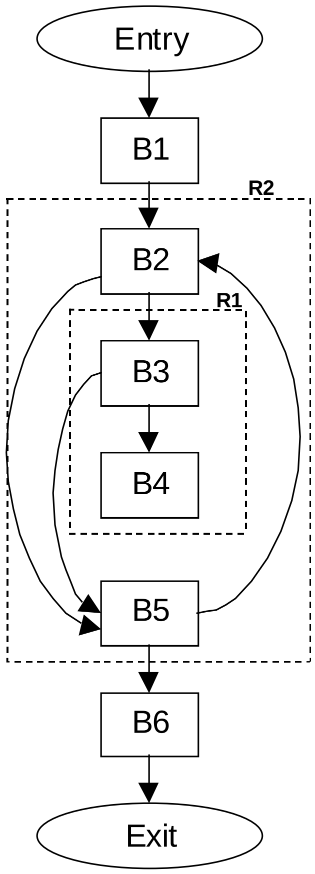
5. Is the Control Flowgraph reducible?

Let's look at the following definition of reducibility in flowgraphs - "… if a flowgraph is reducible, then all the loops in it are natural loops characterized by their back edges and vice versa." Textbook - section 7.5, page 196.

We start looking at the back edges of the Depth First Spanning tree of our CFG. From the DFS tree we can verify that the CFG has two loops given by B4 → B3 and B5 → B2. Furthermore, by checking the CFG dominator tree we can also see that B3 dominates B4 as well as B2 dominates B5. Therefore, we can also determine that the loops given by both B4 → B3 and B5 → B2 are **natural** loops. And since all the loops in the CFG are **natural** loops, we can finally conclude that **yes** – the flowgraph is reducible.

Analysis using Tarjan Intervals

The construction of Tarjan Intervals is a method that also indicates if a CFG is reducible or not. Following, the picture shows the CFG with the Tarjan Intervals R1, R2. All intervals meet the requirement of reducibility – traversing the CFG edges backwards we always get to the header H of the loop before we get to a node with a lower numbering than H. Therefore we can also conclude from Tarjan Intervals Construction that our CFG is reducible.



Tarjan Intervals R1, R2 over the CFG