The basic algorithm for computing live variables

For each basic block *B*, we want to determine

- LVin(B): the set of variables live right before B
- LVout(B): the set of variables live right after B

(remember: “live” means having a potential use in the future)

- To compute these, we use two pieces of information from *B*:
  - USE(B): is the set of variable that are used in B before they ever get re-written in B, i.e. having upwardly exposed uses.
  - DEF(B): is the set of variables rewritten in B

Basic Equations

$$LVin(B) = (LVout(B) - DEF(B)) \cup USE(B)$$
$$LVout(B) = \cup_{S \in Succ(B)} LVin(S)$$

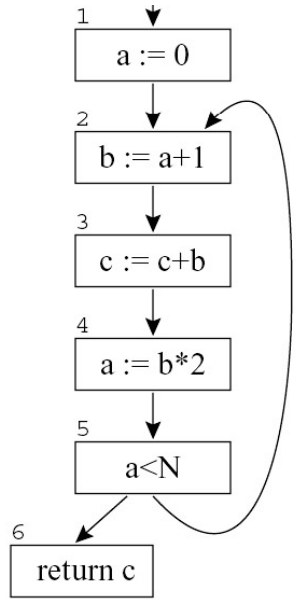
- If we have n basic blocks, then we have simultaneous equations over 2 * n variables: LVin(B) and LVout(B) for all B.
- Borrow the idea from numerical algorithms, we can solve this iteratively
- DEF(B) and USE(B) are "constants"
- Initialize all LVin and LVout variables to empty sets.

- Based on the basic flow equations given above, we initialize LV_out(B) = LV_in(B) = empty for every basic block B
- We then apply the basic equations to the basic block by computing the right-hand side and then update the left-hand side. When we reach the moment when no LV_out(B) can be increased further, we have the final result
- The order in which we visit and revisit basic blocks does not change the final result, but may have an effect on the efficiency of the algorithm, in terms of how many basic blocks are re-visited.
- The most straightforward implementation is to iterate over all basic blocks
- The following is the first example we worked on in class.

B	Use	Def	In	Out	In	Out
1		a		a,c		a,c
2	a	b	a,c	b,c	a,c	b,c
3	b,c	c	b,c	b,c	b,c	b,c
4	b	a	b,c	a,c	b,c	a,c
5	a		a,c	c	a,c	c
6	c		c		c	

Example:

$$
\begin{aligned}
& a \leftarrow 0 \\
L_1 : \; & b \leftarrow a + 1 \\
& c \leftarrow c + b \\
& a \leftarrow b * 2 \\
& \text{if } a < N \text{ goto } L_1 \\
& \text{return } c
\end{aligned}
$$



The table shows result in the first and second (final) iterations. In each iteration, we assume that we visit the basic blocks from 6 to 1.