Implementation of passes:

1. Analysis Pass -- FunctionInfo.cpp:
    a. Function name: use API Function::getName()
    b. Number of arguments: use API Function::arg_size()
    c. Number of basic blocks: use API Function::size()
    d. Number of direct calls: Iterate over all instructions and for each CallInst, get the callee name and increase the callee's call sites count.
    e. Number of instructions: Iterate over all basic blocks and add up number of instructions in each block. For number of instructions in a basic block, I used BasicBlock::size()
2. Transformation Pass – LocalOptimization.cpp:
    a. I implement all optimizations in the same file.
    b. Type of optimizations implemented are documented in the comment in LocalOptimization.cpp
    c. Basically, I iterated through all the instructions once and update the ones which needs to be optimized in place by properly updating the instruction iterator after each modification being made. To detect whether or not a instruction is of the type that I'm interested in (and so potentially can be optimized), I used the APIs to check the operator, operands and users of each instruction.

Note: To run the Analysis Pass, go to folder FunctionInfo and do "make all"; To run the Transformation Pass, go to folder LocalOpts and do "make all".

CSC D10
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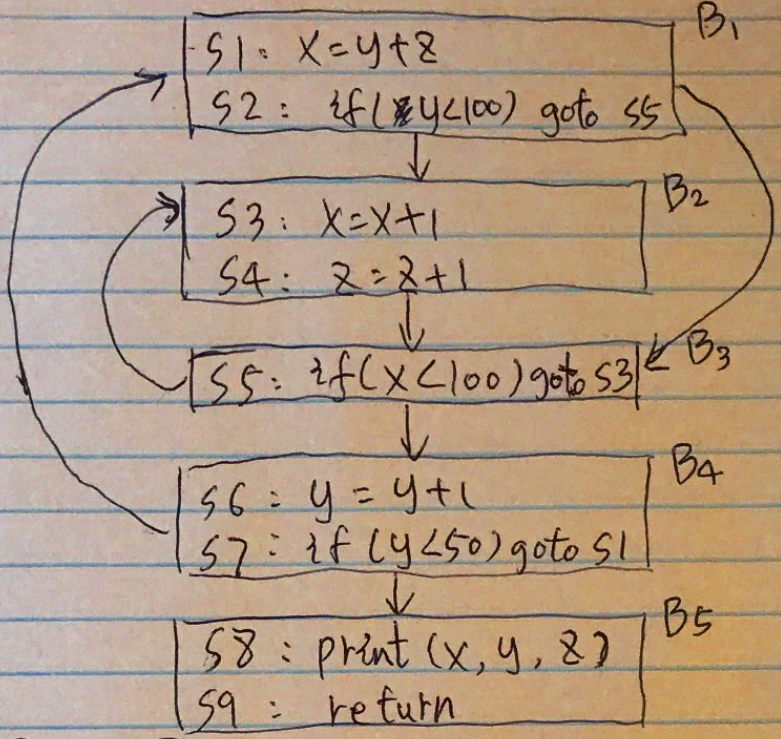
Wang Mingi
Utorid: wangmi56

4.1

(1) Leader instructions: S1, S3, S5, S6, S8

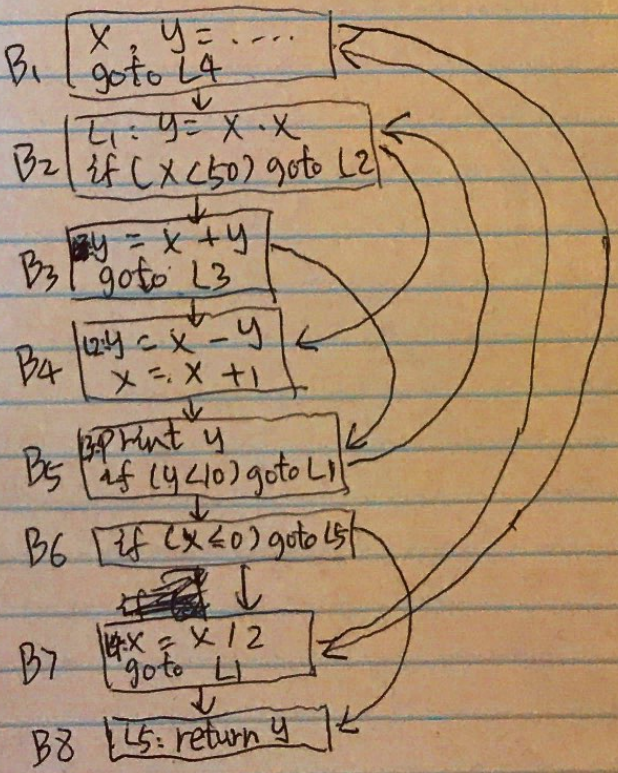
CFG:



(2) Back-edges: B4 → B1

4.2

CFG:



Back-edges: $B_5 \to B_2$, $B_7 \to B_1$

Natural loop for $B_5 \to B_2$: B_2, B_3, B_4, B_5

Natural loop for $B_7 \to B_1$: $B_1, B_2, B_3, B_4, B_5, B_6, B_7$

4.3

(1) The meet operator should be intersection. The reason is that $x \oplus y$ is an available expression at the entry point of a block B iff it is an available expression at the exit point of each of its predecessors, so we need the meet operator to be intersection in order to exclude the unqualified expressions

(2)

BB	GEN	KILL	IN	OUT
1	ϕ	$\{a+b, c-a, b+d, a-d, b \cdot d\}$	ϕ	ϕ
2	$\{a+b, c-a\}$	$\{b+d, a-d, b \cdot d\}$	$\{c-a\}$	$\{a+b, c-a\}$
3	ϕ	$\{b+d, a-d, b \cdot d\}$	$\{a+b, c-a\}$	$\{a+b, c-a\}$
4	$\{a+b\}$	$\{b+d, e+1, a-d, b \cdot d\}$	$\{a+b, c-a\}$	$\{a+b, c-a\}$
5	$\{c-a\}$	$\{a+b, b+d, e+1, b \cdot d\}$	$\{a+b, c-a\}$	$\{c-a\}$
6	$\{a-d\}$	$\{a+b, b+d, b \cdot d\}$	$\{c-a\}$	$\{c-a, a-d\}$