[CS201]Project 2 Liveness Analysis

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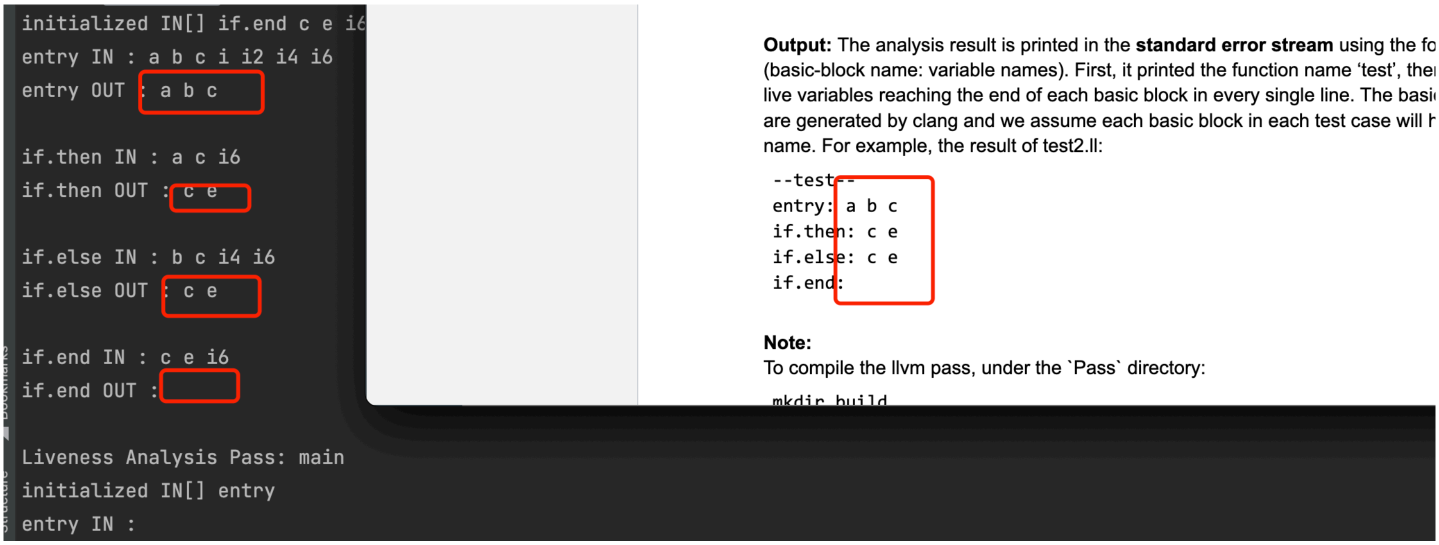
Result



to get the correct reuslt, we should add "-fno-discard-value-names" flag when generating .ll file.

Usage:

```
opt -instnamer -enable-new-pm=0 -load ./libLLVMLivenessAnalysisPass.so   -LivenessAnalysis ./test.ll
```

Design

As we learned at class, there are 2 main steps:

1. Initialize

```
 IN[B]: Variables live at B's entry.
 OUT[B]: Variables live at B's exit.
 GEN[B]: Variables that are used in B prior to their definition in B.
KILL[B]: Variables definitely assigned value in B before any use of that variable in
B.

-- Initialize sets:
for every block B
   IN[B] = GEN[B]  //(GEN[B]: Variables that are used in B prior to their definition
in B.
   OUT[B] = φ
```

2. Iterate

```
-- Iteratively solve equations:
change = true;
while change {
    change = false;
    for each B ≠ Be {
    OLDIN = IN[B]
    OUT[B] =    s Ɛ succ(B)  U(IN[S])
    IN[B] = GEN[B] U (OUT[B] – KILL[B])
    if IN[B] ≠ OLDIN then change = true
 }
}
```

Impelement

For step 1, we will focus on these types of operations:

```
if(inst.getOpcode() == Instruction::Add || inst.getOpcode() == Instruction::Sub
|| inst.getOpcode() == Instruction::Mul || inst.getOpcode() == Instruction::SDiv
|| inst.getOpcode()==Instruction::PHI || inst.getOpcode()==Instruction::ICmp
|| inst.getOpcode()==Instruction::Load || inst.getOpcode() == Instruction::Store)
```

The only unique one is store whose second oprands will be added to "kill" set. Otherwise, the operands will be added to "gen set".

For step2, we can use "rbegin()" to simulate the "post propogation"

```
bool change = true;
while(change){
    change = false;
```

```
    for(auto it = bbs.rbegin(); it!=bbs.rend();it++){
        // ....
        //         OUT[B] =    s Ɛ succ(B)  U(IN[S])
        //         IN[B] = GEN[B] U (OUT[B] — KILL[B])
        for(const BasicBlock *succ : llvm::successors(&bb)){
            auto succ_out = OUT[succ];
            auto succ_in = IN[succ];
            std::set_union(succ_in.begin(), succ_in.end(),
                           new_out.begin(), new_out.end(), std::inserter(new_out,
new_out.begin()));
        }// get OUT[B]
        auto out_diff_kill = std::set<const StringRef>();
        std::set_difference(new_out.begin(),new_out.end(),
                            kill.begin(),kill.end(),std::inserter(out_diff_kill,
out_diff_kill.begin()));
        std::set_union(gen.begin(),gen.end(),
                       out_diff_kill.begin(),out_diff_kill.end(),std::inserter(new_in,
new_in.begin()));
        if(new_in != old_in){
            change = true;
        }
    }
}
```