Sanitizer & LLVM Pass

SWPP

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Clang Sanitizer

- A tool that helps you detect undefined behaviors at runtime
- `clang -fsanitize=XXX a.c`
  - `undefined`: detects UBs from arithmetic operations
  - `address`: detects use-after-free, etc
  - `memory`: detects reading uninitialized memory
  - They are all undefined behaviors in C!

Running Example

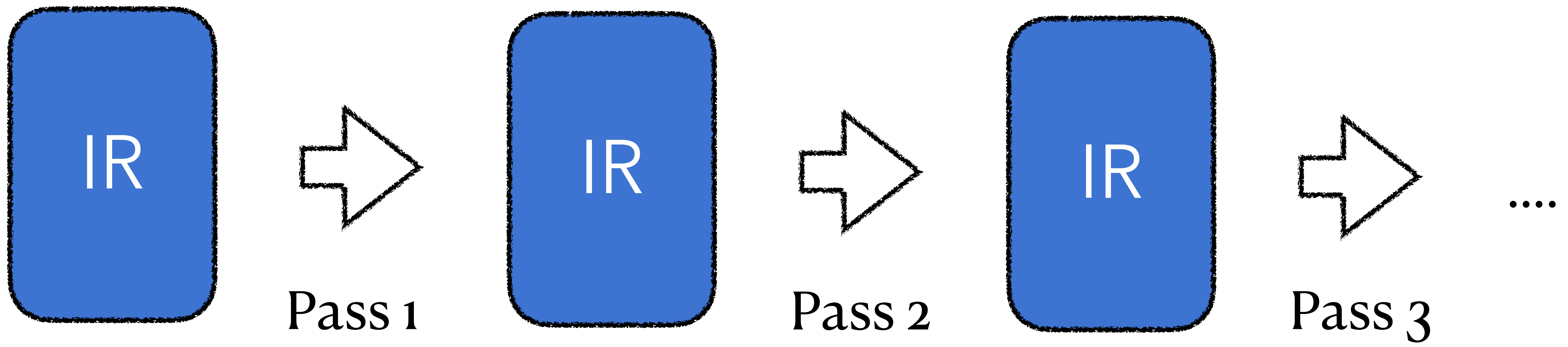
```c
// ubsan.c
#include<stdio.h>

int main() {
  printf("Type two positives to calculate average: ");
  int a, b;
  scanf("%d %d", &a, &b);

  int average = (a + b) / 2;
  printf("Average: %d\n", average);

  return 0;
}
```

Solution

```c
// ubsan.c
#include<stdio.h>

int main() {
  printf("Type two positives to calculate average: ");
  int a, b;
  scanf("%d %d", &a, &b);

  int average = a + (b - a) / 2;
  printf("Average: %d\n", average);

  return 0;
}
```

Let’s see other three tests as well!

LLVM IR Pass



- Each transformation (or optimization) is called pass.
- -O1, -O2, -O3: a set of (more) passes.
- Prerequisite: LLVM

1. HelloPass

- Full code: hello.cpp

```
class HelloPass : public PassInfoMixin<HelloPass> {
public:
  PreservedAnalyses run(Function &F, FunctionAnalysisManager &FAM) {
    StringRef funcName = F.getName();
    outs() << "Hello, " << funcName << "!\n";
    return PreservedAnalyses::all();
  }
};

extern "C" ::llvm::PassPluginLibraryInfo
llvmGetPassPluginInfo() {
  // Registration of HelloPass: omitted for brevity
}
```

Hierarchy

- llvm::Module class
- llvm::Function class
- llvm::BasicBlock class
- llvm::Instruction class

To see class hierarchy & their methods..

Search Google / Read code / See Autocompletions

inherits (is-a)

llvm::LoadInst	llvm::ICmpInst	llvm::BinaryOperator
llvm::StoreInst	llvm::BranchInst	llvm::PHINode...

How To Run HelloPass?

- Compile: it is slightly complex.. Please use ./run-passes.sh build <build dir>
    - If you like to challenge, have a look at the script! It isn't very hard
- Run: ./run-passes.sh run <build dir> also works, but you can try:
    - opt -disable-output -load-pass-plugin=libHello.so -passes="hello" foo.ll

2. DumpPass

```
class DumpPass : public PassInfoMixin<DumpPass> {
public:
  PreservedAnalyses run(Function &F, FunctionAnalysisManager &FAM) {
   outs() << "<<" << F.getName() << “>>\n";

    for (BasicBlock &BB : F) {
      outs() << "BasicBlock: " << BB.getName() << “\n";

      for (Instruction &I : BB)
        outs() << "\t" << I << "\n";
    }
    return PreservedAnalyses::all();
  }
};
```

Print Successors

```
class DumpPass : public PassInfoMixin<DumpPass> {
public:
  PreservedAnalyses run(Function &F, FunctionAnalysisManager &FAM) {
    for (BasicBlock &BB : F) {
      outs() << "BasicBlock: " << BB.getName() << "\n";

      unsigned successorCnt = BB.getTerminator()->getNumSuccessors();

      for (unsigned i = 0; i < successorCnt; ++i) {
        BasicBlock *NextBB = BB.getTerminator()->getSuccessor(i);
        outs() << NextBB->getName() << "\n";
      }
    }
    return PreservedAnalyses::all();
  }
};
```