

Symbiotic: finding bugs in C programs

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DevConf 2019 , 25. 1. 2019

- Nowadays, we usually use testing to find bugs.
- It is hard to write tests that reveal bugs.
- Automatic test generation can be used.

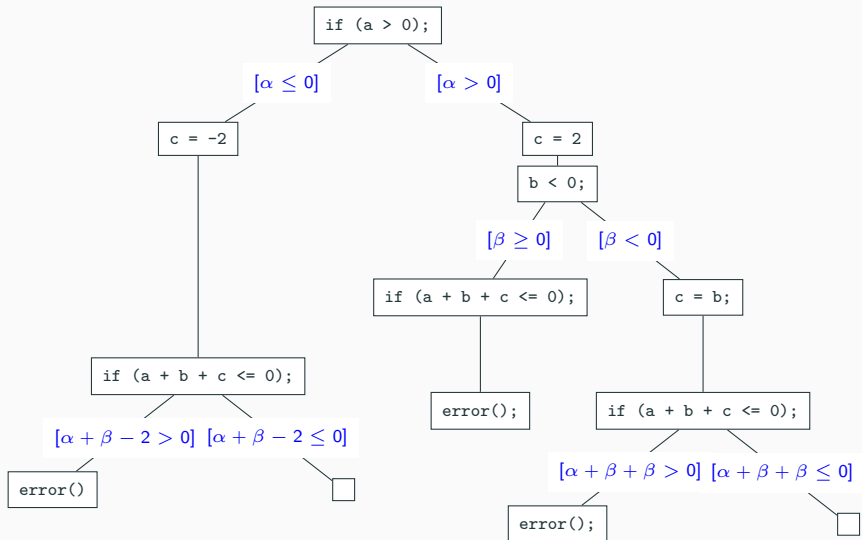
Symbolic Execution

- Given a program with inputs:
 - use symbols instead of inputs,
 - execute the program with these symbols,
 - fork the execution on branchings.
- This way we can enumerate all possible paths in the program.

```
void foo(int a, int b, int c)
{
    if (a > 0) {
        c = 2;
        if (b < 0) {
            c = b;
        }
    } else {
        c = -2;
    }
    if (a + b + c <= 0)
        error();
}
```

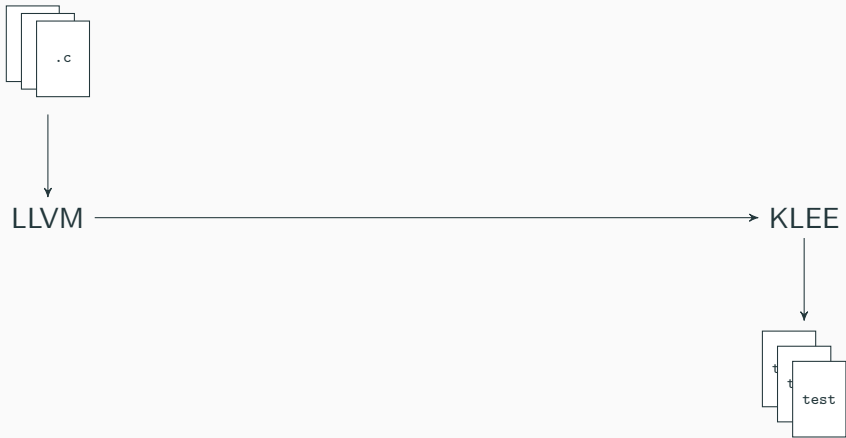
Symbolic execution

$a := \alpha, b := \beta, c := \gamma$



- Open-source symbolic executor for LLVM bitcode.
- <http://klee.github.io/>





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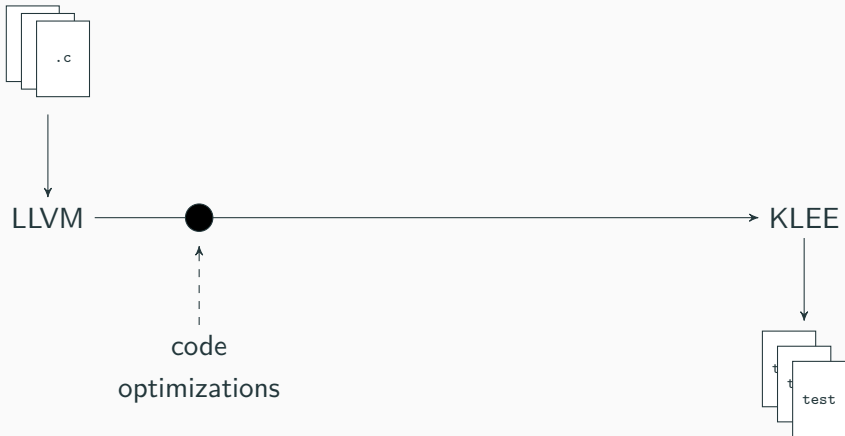


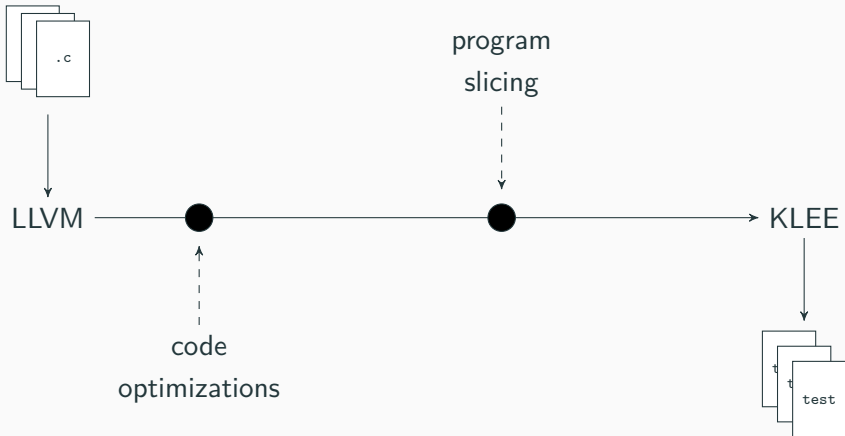
Preprocess the code before giving it to KLEE.

Symbiotic



Symbiotic





- Compute dependencies between instructions.
- We say that instruction A depends on instruction B if:
 - instruction A uses values generated by instruction B, or
 - instruction A is not executed if we go some other way at (branching) B
- Slicing: keep only the instructions on which the error (transitively) depends.

Program Slicing – Example

```
int zeroing(char *buf, size_t size)
{
    int n = input();
    for (int i = 0; i < n; ++i) {
        assert(i < size && "Out_of_bounds");
        buf[i] = 0;
    }

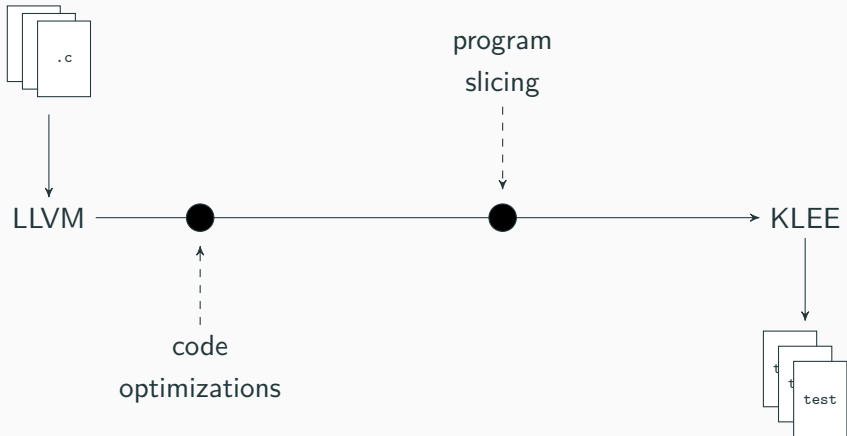
    return 0;
}
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Program Slicing – Example

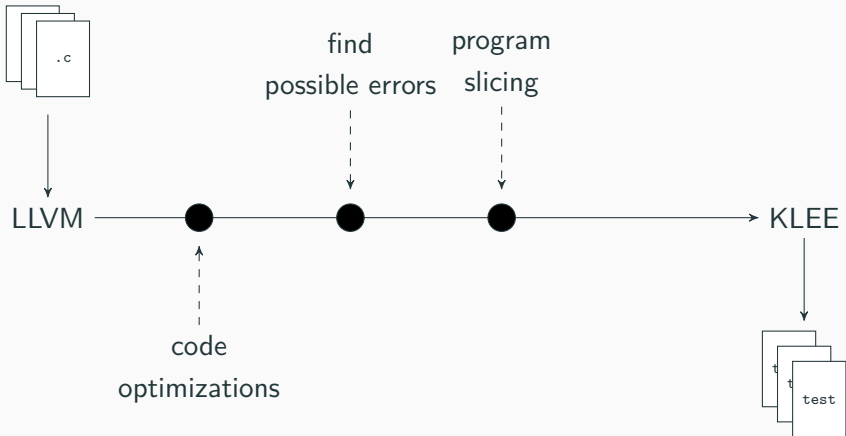
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Symbiotic - cont.



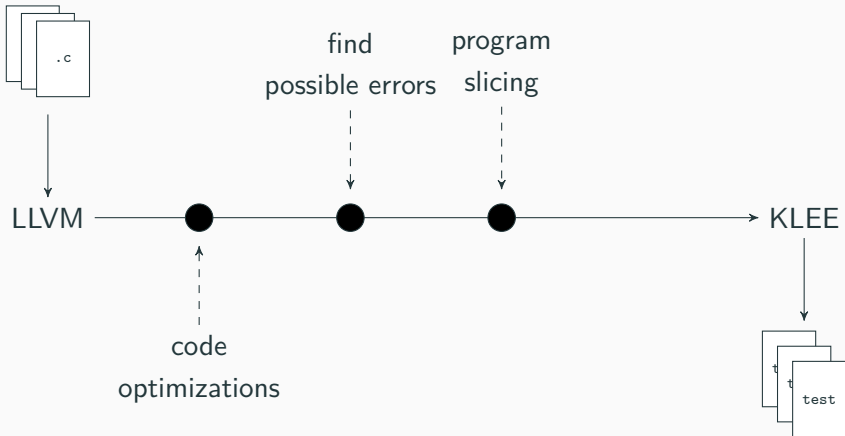
Symbiotic - cont.



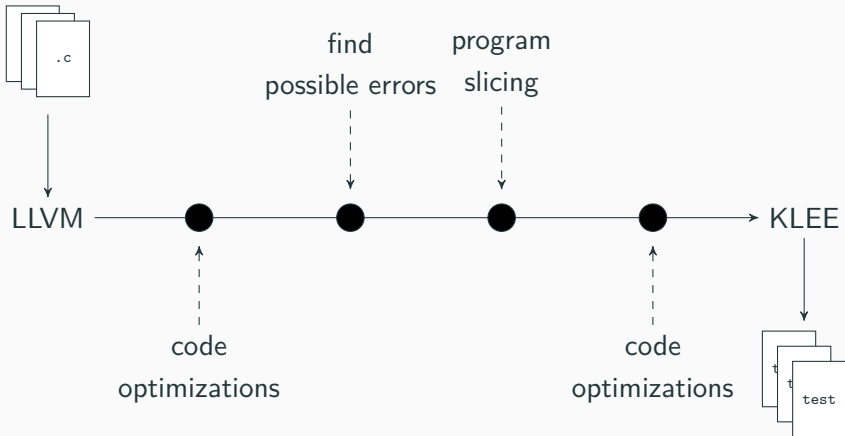
Finding possible errors

- Symbiotic performs light-weight static analysis before slicing.
- The static analysis looks for chosen errors (integer overflow, double free, dangling pointer dereference,...).
- Instructions that *may* exhibit an error are set as slicing criteria.

Symbiotic - cont.



Symbiotic - cont.



- Apart from the already mentioned steps, Symbiotic:
 - automatically marks memory symbolic,
 - replaces undefined functions with symbolic stubs.
- Limits: no C++ (exceptions), no threads (yet).
- Unfortunately, Symbiotic still does not scale to large programs.

Future Directions

- Scalability
 - slicing (faster analyses),
 - symbolic execution (abstraction),
 - different back-ends than KLEE.
- Better modelling of the environment (POSIX).
- C++ and threads.

Conclusion

- Symbiotic is a tool for finding bugs in C programs.
- Combines fast static analysis with program slicing and symbolic execution.
- Runs on sequential C code.
- Still needs some work
 - scalability issues,
 - no C++ and threads

Conclusion

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- Combines fast static analysis with program slicing and symbolic execution.
- Runs on sequential C code.
- Still needs some work
 - scalability issues,
 - no C++ and threads

<https://github.com/staticafi/symbiotic>

Thank you!