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# Beyond a Joke: Dead Code Elimination Can Delete Live Code

**Haoxin Tu**, Lingxiao Jiang, Debin Gao (Singapore Management University)
He Jiang (Dalian University of Technology)

18/04/2024, Lisbon

# Background: Dead Code Elimination



- **What is Dead Code Elimination (DCE)?**
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  int b = 25; /* Assignment to dead variable */
  int c;
  c = a * 4;
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  b = 24; /* Unreachable code */
  return 0;
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```c
int main(void) {
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  if (0) {   /* DEBUG */
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Examples are cited from https://en.wikipedia.org/wiki/Dead-code_elimination#Examples

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- Benefits of DCE: produce ***smaller*** or ***faster*** executables
  - Many other applications and languages (Java, Go, and Rust, etc.)

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A Wrap lines

x86-64 clang 12.0.0 | -O3 -std=c99

(Input) 0x99

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Program returned: 143
Program stderr
```

(Output)

```
Killed - processing time exceeded
Program terminated with signal: SIGKILL
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https://godbolt.org/z/z7zxexfr1

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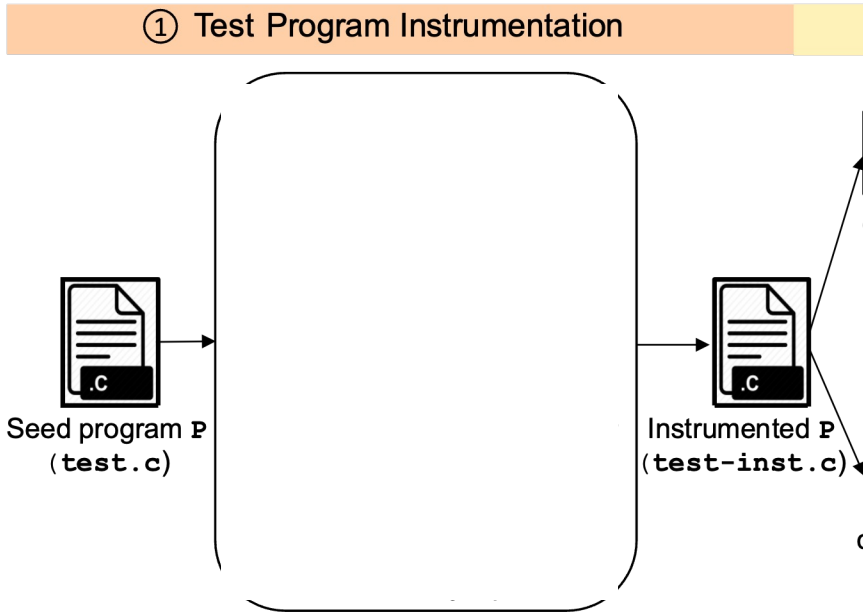

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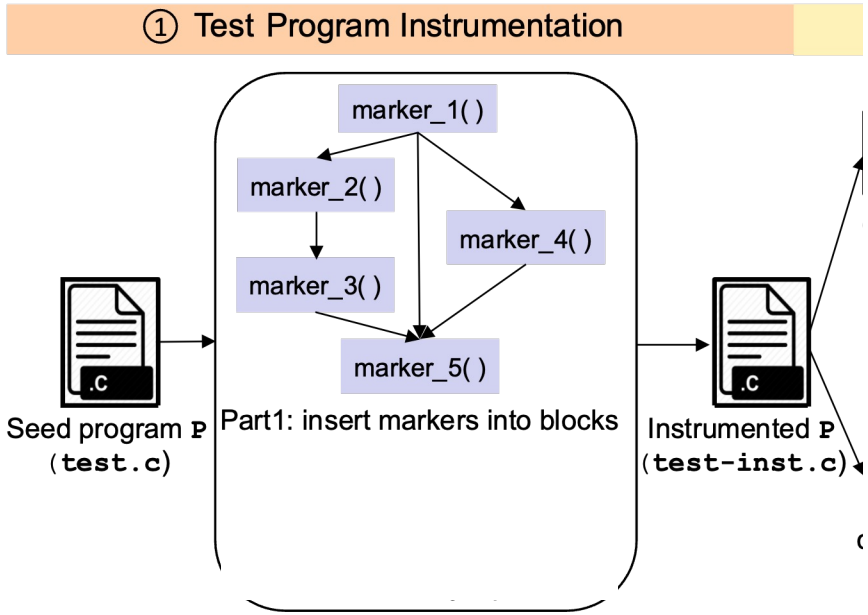


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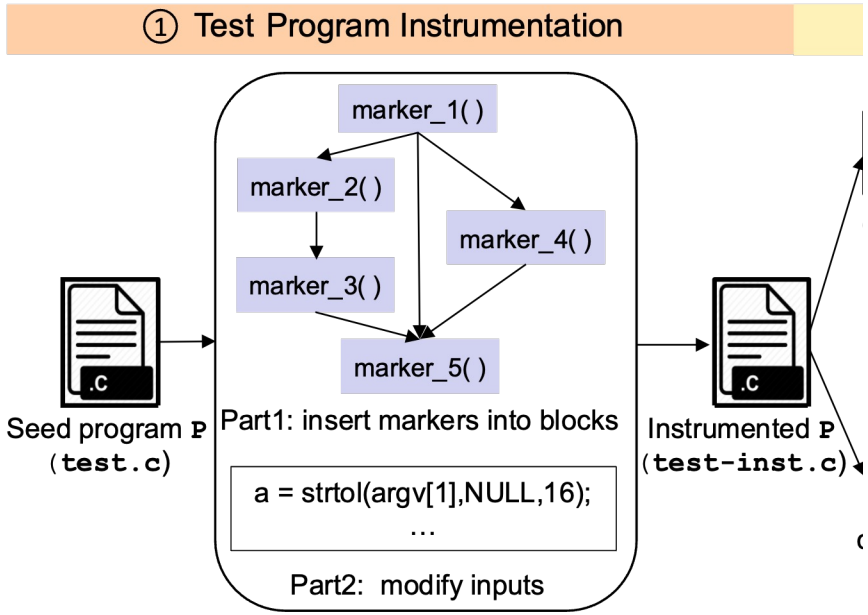


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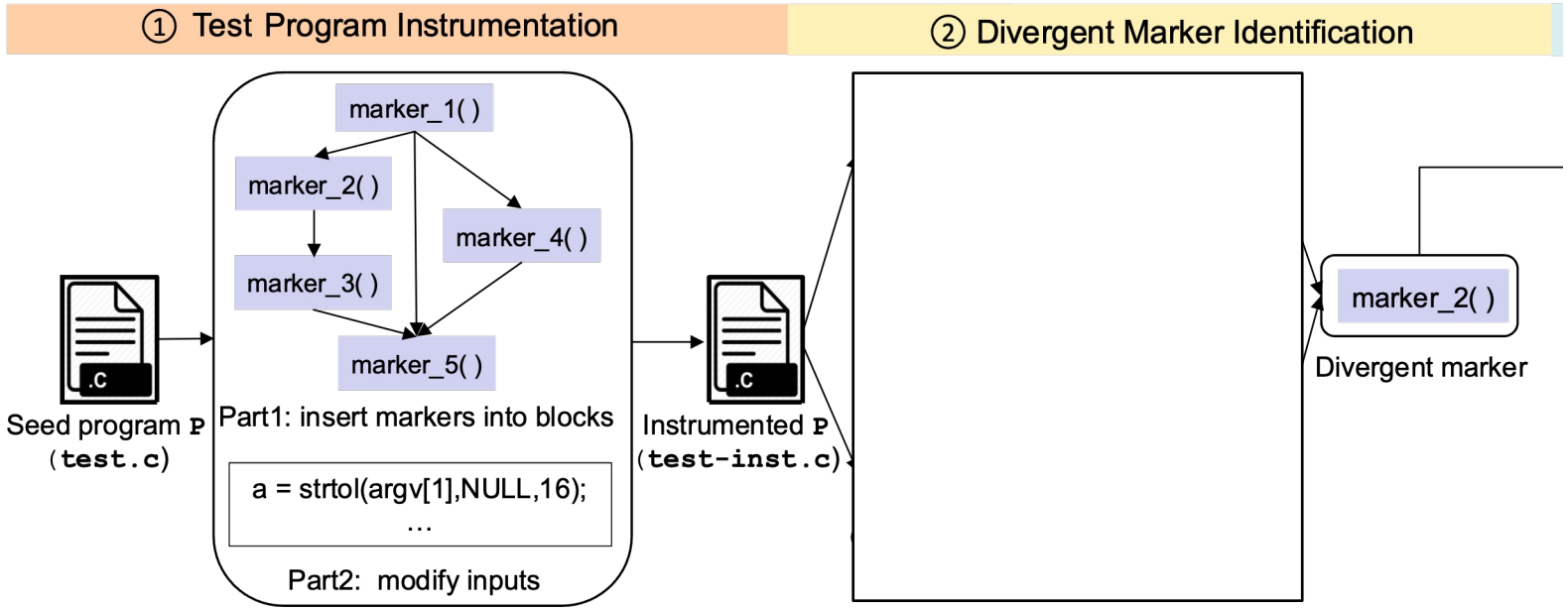


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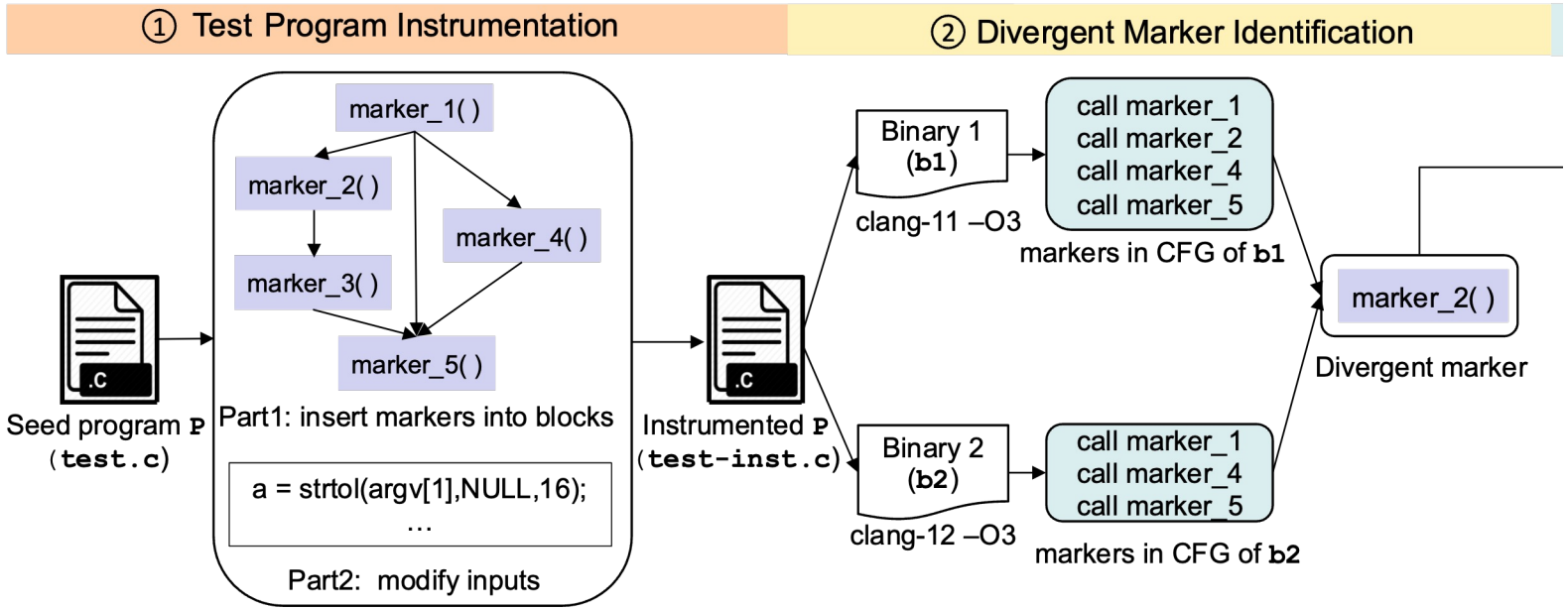


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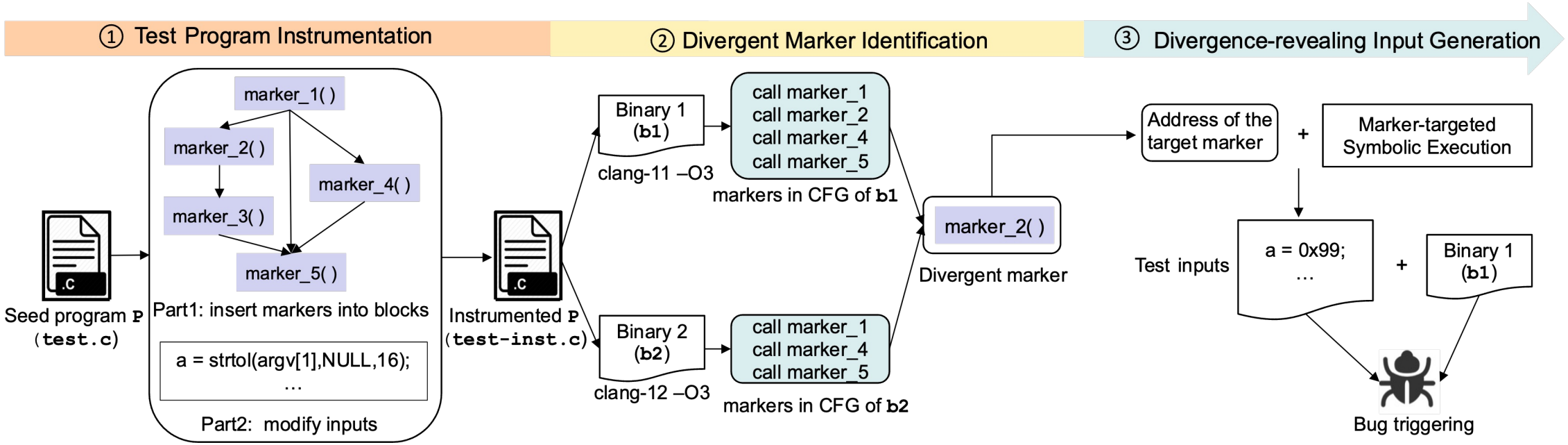


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  - Benchmark
    - **10,000** seed program from Csmith
  - Subjects
    - GCC and LLVM
  - Running setting
    - four scenarios under “–O3”

- **Metric**
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| GCC-10/11 (-std=c99) | 52,553 | 0 | 5,897 | 58.97% | 8.91 |
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## ➢ Summary

- Found many divergent portions indicating erroneously deleted live code (i.e., wrong compiler optimization opportunities)
- Detected ***Two*** miscompilation bugs in LLVM compilers

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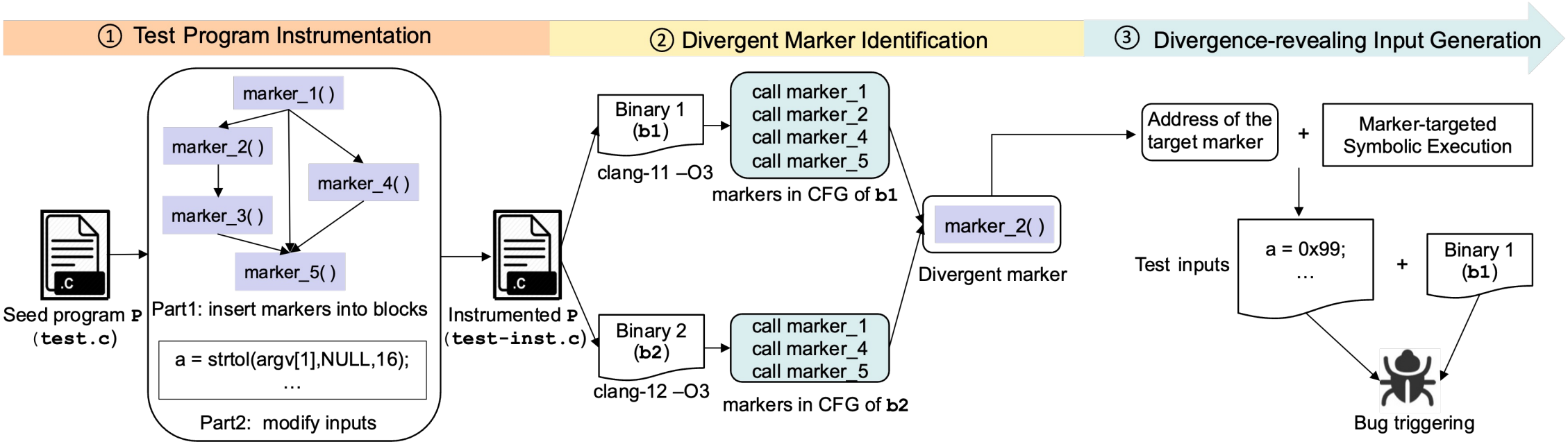

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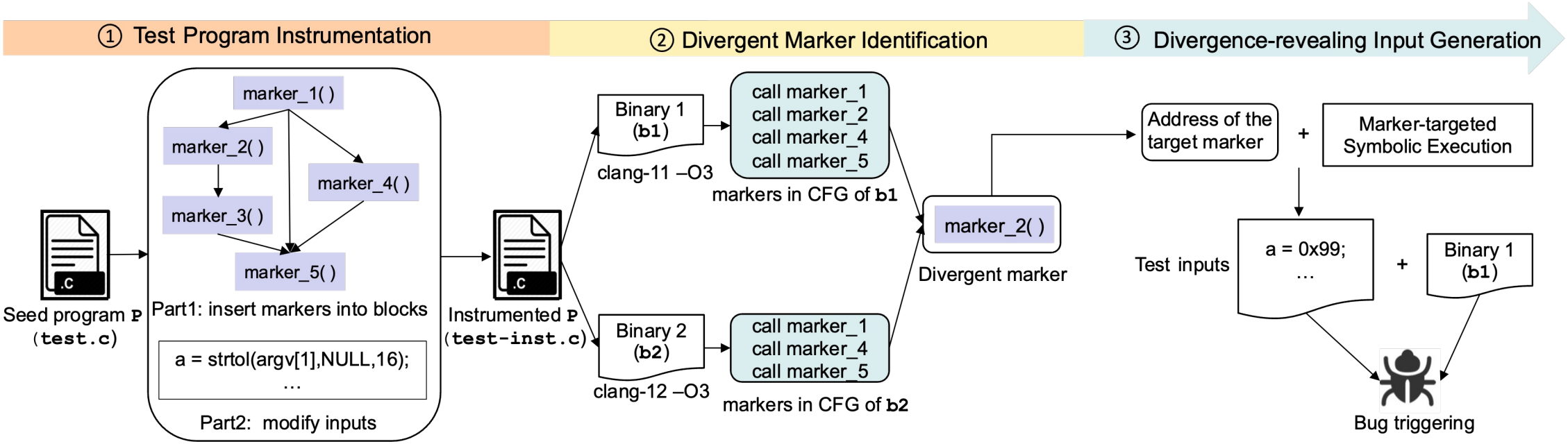


- **Future work**
  - Utilize more fine-grained binary analysis to identify fine-grained divergent portions in **Part 1**
  - Improve the efficiency of **Part 3**
    - efficient path exploration

**Paper** **Code**

# Thank you & Questions?

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- Symbolize the input (i.e., variable a) in the program
- Set the target to find (i.e., the address of function marker_2)
- execute ***Angr*** (a binary symbolic executor)

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## ➢ Step 3: Divergence-revealing Input Generation

- Symbolize the input (i.e., variable a) in the program
- Set the target to find (i.e., the address of function marker_2)
- execute ***Angr*** (a binary symbolic executor)

## ➢ Execution results

- "Found a solution!": e.g., 0x99
- "No solution found": not a DCE bug or Angr encounter difficulties

# Related work

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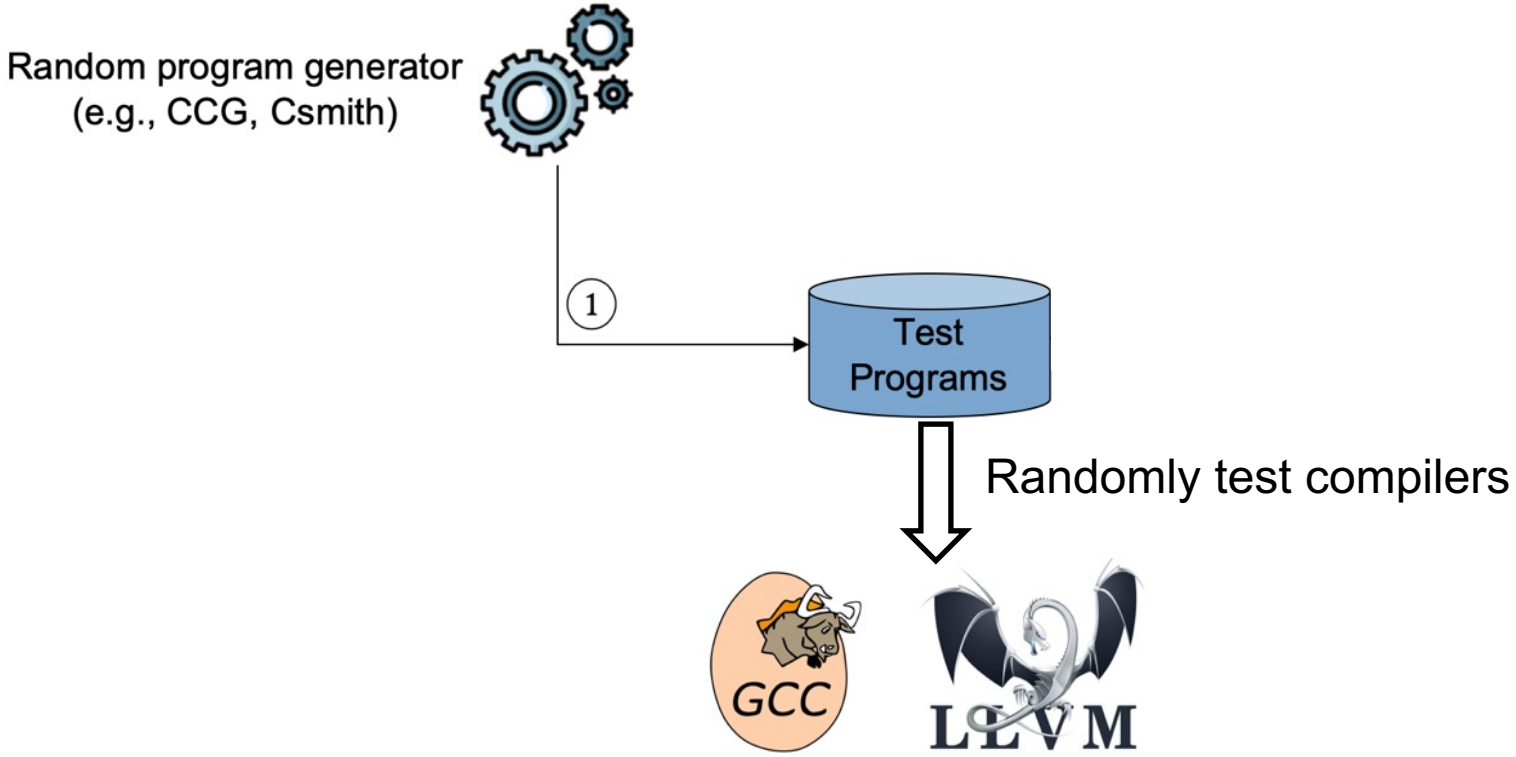


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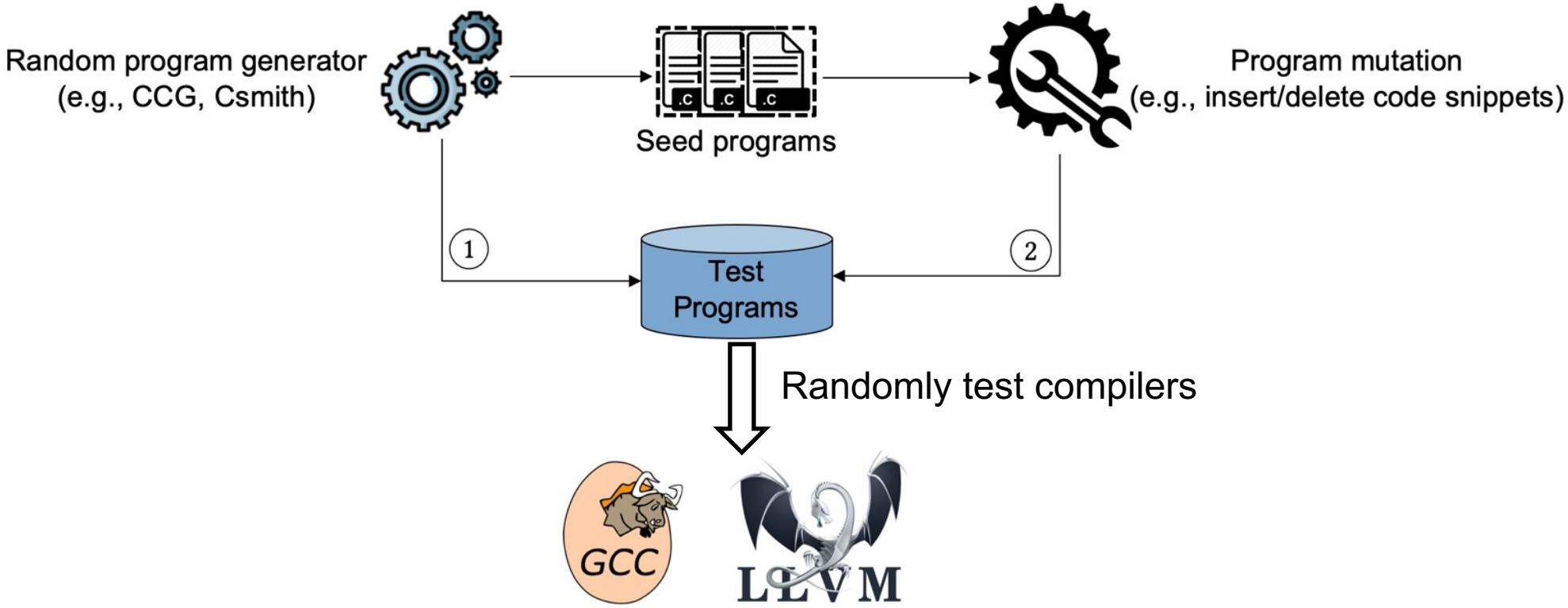


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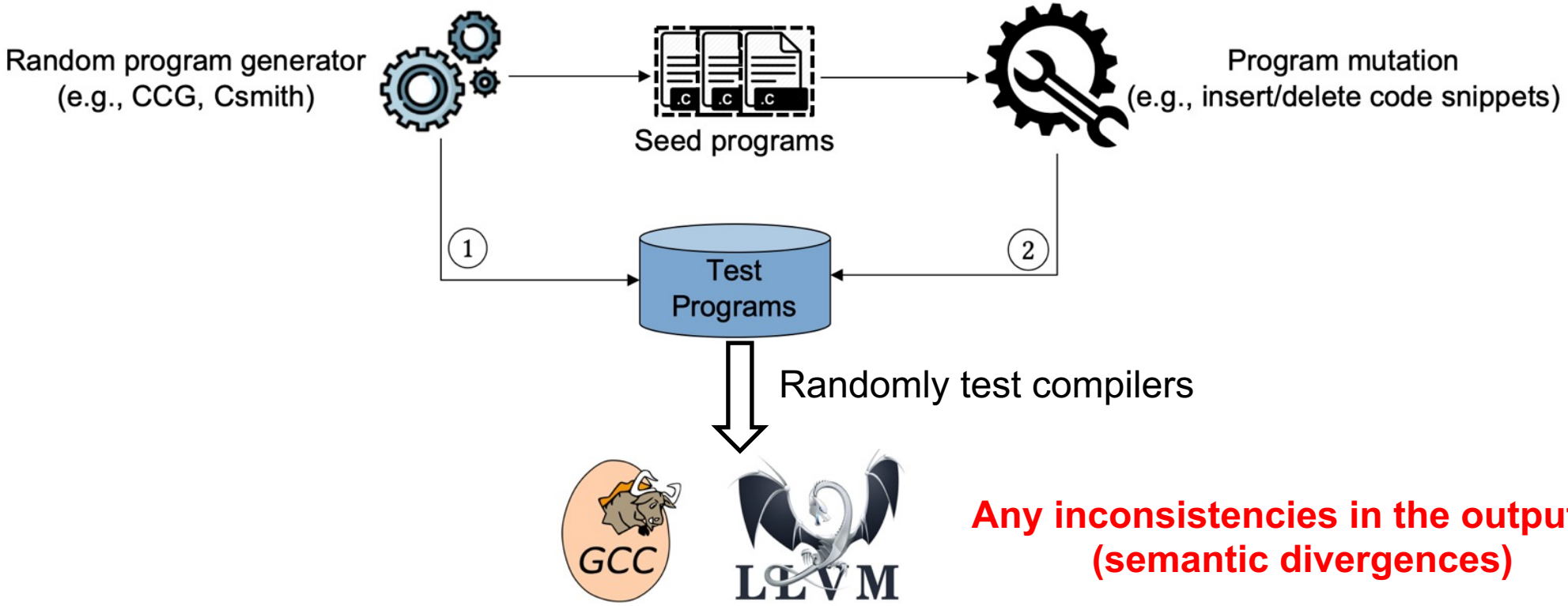


**Any inconsistencies in the outputs?**
**(semantic divergences)**

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# Future work (1/2)

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- **Insights**
  - ✓ Reducing the search space of symbolic exploration could make targeted symbolic execution more efficient

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## ➢ Insights

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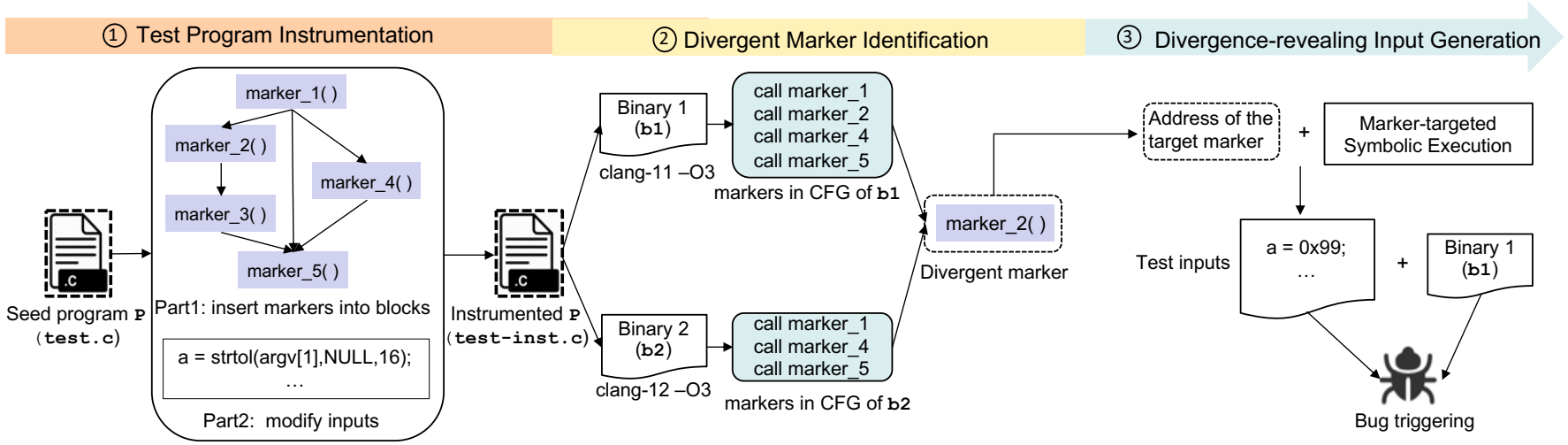

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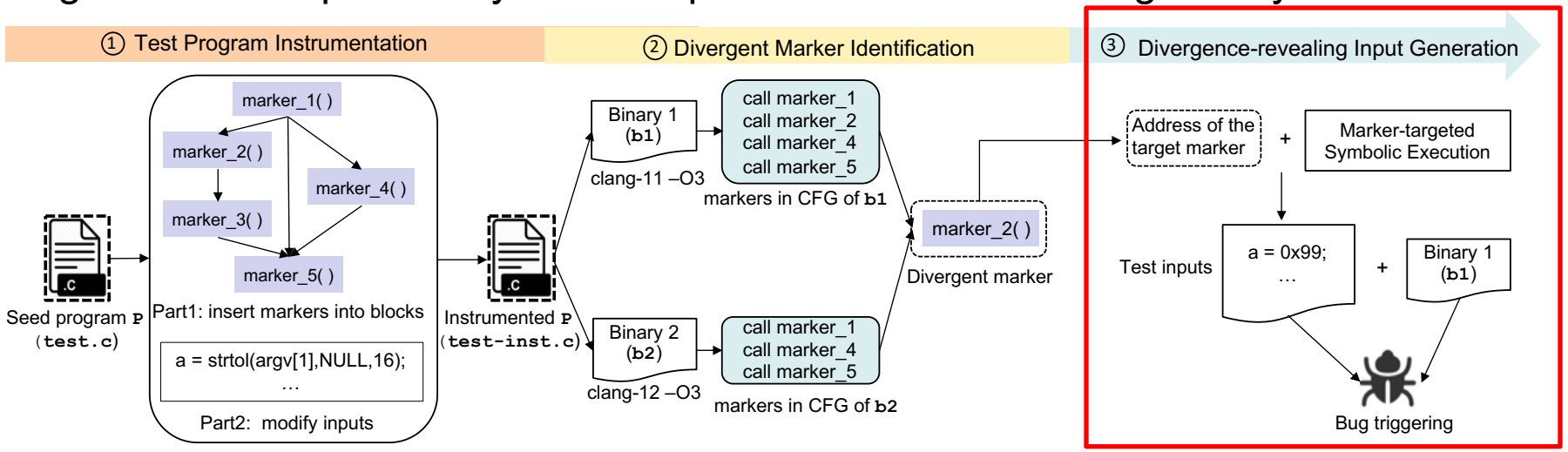

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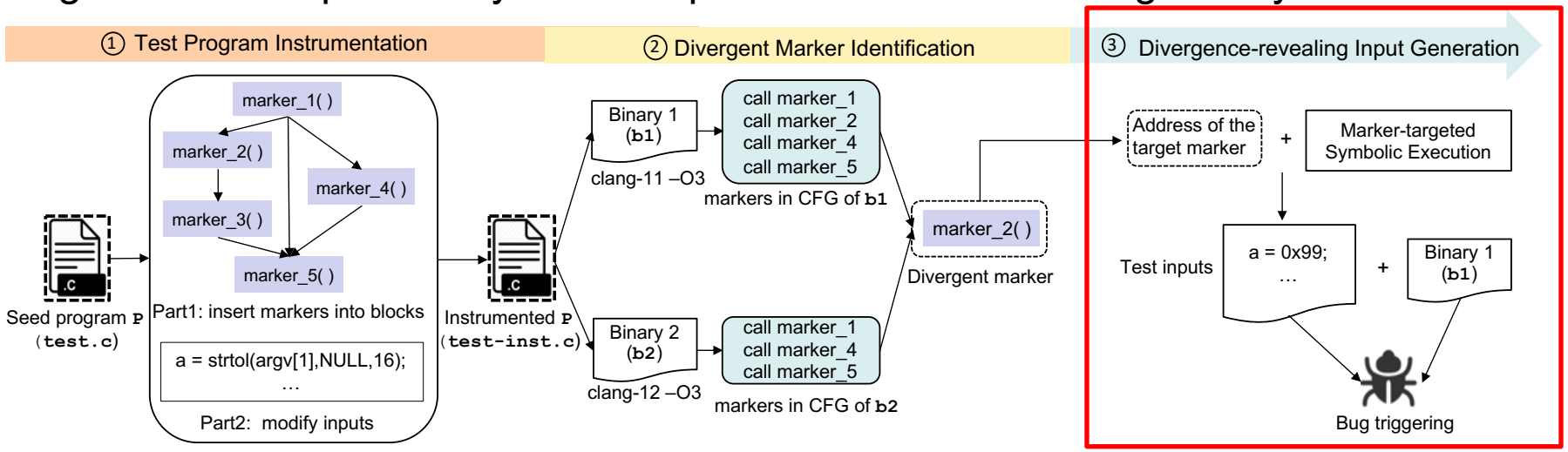


- **Challenge 1: how to select important variables to be symbolized?**
  - Not every variable contributes equally to revealing the divergent portion in binaries
- **Challenge 2: how to handle loops or function calls involved with symbolic variables?**
  - Such loops or functions make the target symbolic execution inefficient

# Future work (2/2)

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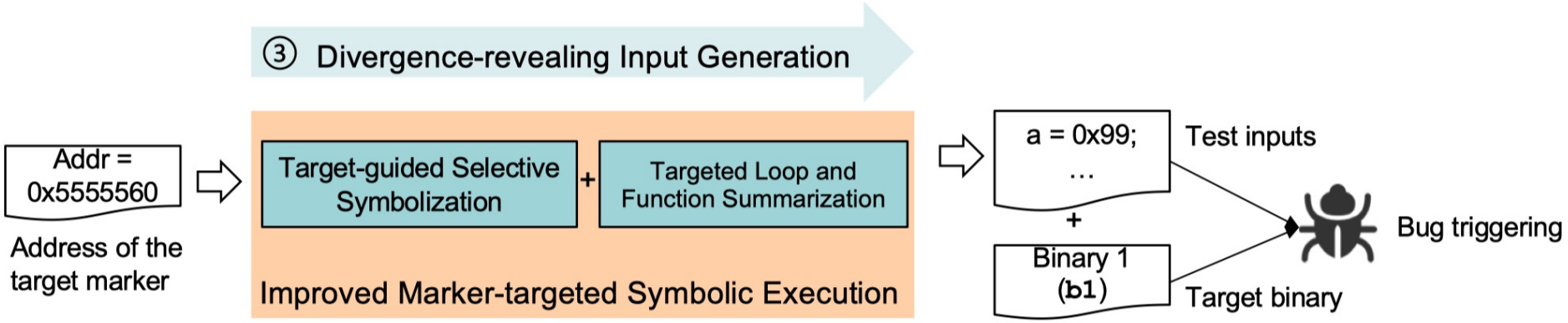
- **Planned solution: efficient targeted symbolic execution**



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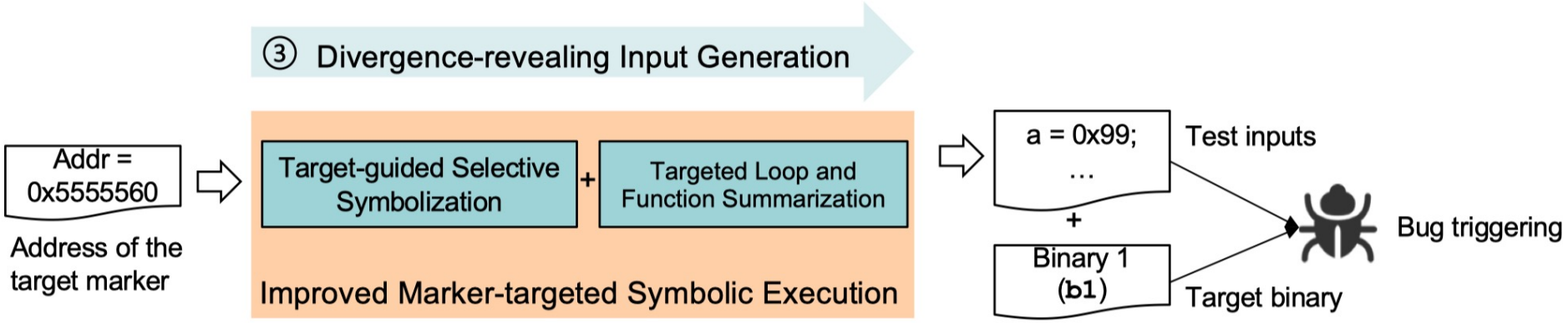
- **Planned solution: efficient targeted symbolic execution**




- **Addressing challenge 1: Target-guided selective symbolization**
  - Data flow analysis to select variables that are directly to go through the divergent functions
- **Addressing challenge 2: Targeted loop and function summarizations**
  - Handle loops and functions that involve symbolic variables