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VeriExploit: Automatic Bug Reproduction in Smart Contracts via LLMs and Formal Methods

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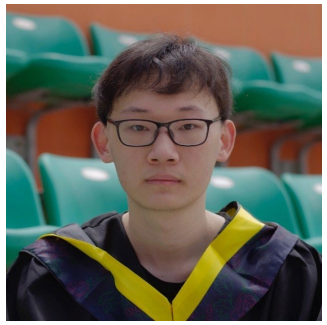

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Motivation

Reproducing found bugs can be hard

- Bug finders (e.g. verifiers) detect issues but rarely provide executable reproductions.
- Many bugs are cross-contract and multi-step (e.g. reentrancy)
  - ➢ hand-crafting attacker contracts + call sequences is slow and error-prone.
- In Solidity smart contracts, reproduction is more challenging
  - ➢ requires an attacker contract and a clear exploit path/trace.

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Why Reproducing Bugs?

- **Understanding & Fixing**: Generate attacker contracts to help developers understand vulnerabilities.
  - ➢ (Ballesteros et al., 2022), (Wu et al., 2024).
- **Detection & Forecasting**: Pair adversarial with vulnerable contracts to detect/anticipate attacks.
  - ➢ (Wang et al., 2024)
- **Vulnerability Discovery**: Generate exploit PoCs to validate the (LLM-based) bug findings.
  - ➢ (Gervais & Zhou, 2025), (Xiao et al., 2025)

Our primary goal is *Understanding*, but the generated contracts are also suitable for *Forecasting*

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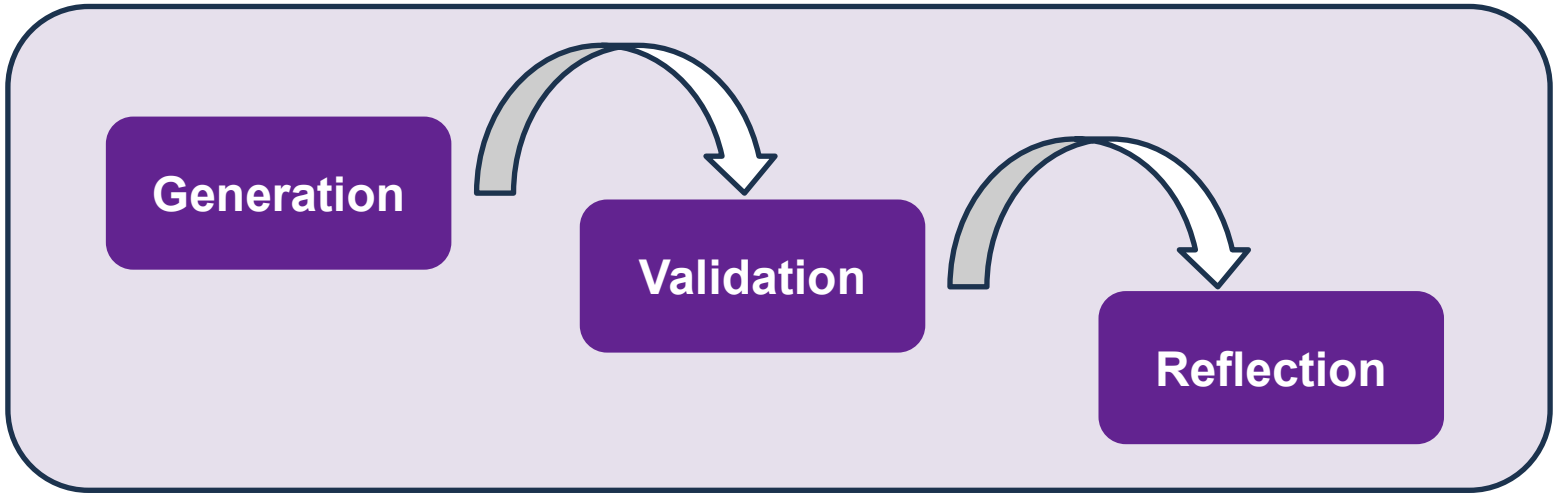
Our Solution: VeriExploit

- LLM-guided generation of attacker contracts.
- Bounded cross-contract verification (BCCV).
- Automatically validates exploits and reports executable steps.
- Generalizes across multiple vulnerability types.



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Algorithm Overview

Given:

- Vulnerable and attacker contracts.
- A verifier that supports unbounded reasoning.

VeriExploit checks:

- If an attacker path reproduces the reported bug, we provably find it.
- Otherwise, we formally diagnose why: **unreachable** or **incorrect parameters**. (args, caller, value, pre-state)

Key Numbers

Dataset: **100** samples from open-sourced contacts, covering **six** bug types.

85.6%
Overall success (ESBMC)
Validated exploits across all benchmarks

64.6%
Overall success (SolCMC)
Performance on the same dataset

11.8%
LLM-only baseline
Without verifier feedback

+20.6 pp
Self-reflection gain
From 65.0% to 85.6% (ESBMC)

90.9%
AdvScanner comparison
vs 88.5% (AdvScanner)

Evaluation: 5 trials per case, GPT-4o, reflection limit = 5, per-run timeout = 120 s.

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Thank you!