Smart Contract Security

Smart Contracts

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What can go wrong when programs handle billions of USD?

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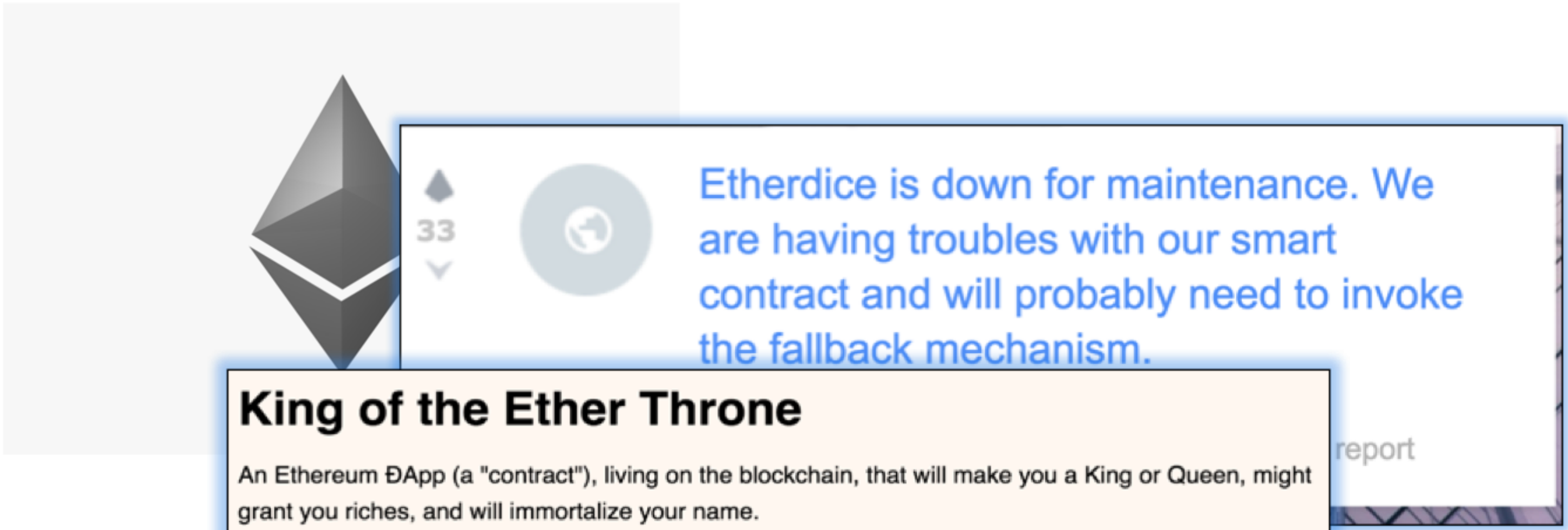
- Small programs that ***handle money*** (ether)
- Executed on the Ethereum blockchain
- Written in high-level languages (*e.g.*, Solidity)
- ***No patching*** after release

What can go wrong when programs handle billions of USD?

Funds Stolen From the DAO One Year Ago Would be Worth $1.35bn Today

JP Buntinx June 18, 2017 Crypto, News



Security Bug #1: Reentrancy

Wallet Contract

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uint balance = 10;

function withdraw(){
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Security Bug #1: Reentrancy

User Contract

```
function moveBalance() {
  wallet.withdraw();
}
...
```

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Later…

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no transfer

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10 ether

Later…

withdraw()

no transfer

Can the user contract withdraw more than 10 ether?

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Security Bug #1: Reentrancy

User Contract

```
function moveBalance() {
  wallet.withdraw();
}
...
function () payable {
  // log payment
}
```

Wallet Contract

```
uint balance = 10

function withdr
  if(balance > 0)
    msg.sender.call.value(balance)();
  balance = 0;
}
```

calls the default "payable" function

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balance is zeroed ***after*** ether transfer

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}
...
function () payable {
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}
```

Calls withdraw() before balance is set to 0

Wallet Contract

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uint balance = 10;

function withdraw(){
  if(balance > 0)
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}
```

balance is zeroed ***after*** ether transfer

An adversary stole 3.6M Ether !

Security Bug #2: Unprivileged write to storage

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Wallet Contract

```
address owner = ...;

function initWallet(address _owner) {
  owner = _owner;
}

function withdraw(uint amount) {
  if (msg.sender == owner) {
    owner.send(amount);
  }
}
```

Security Bug #2: Unprivileged write to storage

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Only owner can send ether

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Any user may change the wallet's owner

Only owner can send ether

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}
```

Only owner can send ether

An attacker used a similar bug to ***steal $32M***

More security bugs

Unexpected ether flows

Insecure coding, such as unprivileged writes *(e.g., Multisig Parity bug)*

Use of unsafe inputs (e.g., reflection, hashing, …)

Reentrant method calls *(e.g., DAO bug)*

More security bugs

Unexpected ether flows

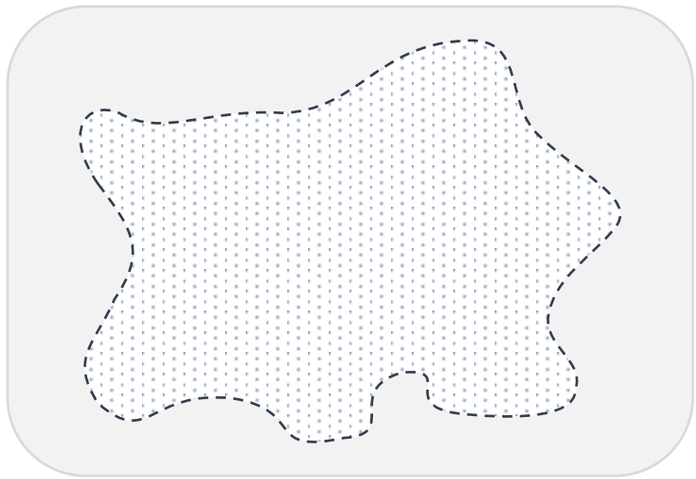
Insecure coding, such as unprivileged writes *(e.g., Multisig Parity bug)*

Use of unsafe inputs (e.g., reflection, hashing, …)

Reentrant method calls *(e.g., DAO bug)*

Transaction reordering

Automated Security Analysis



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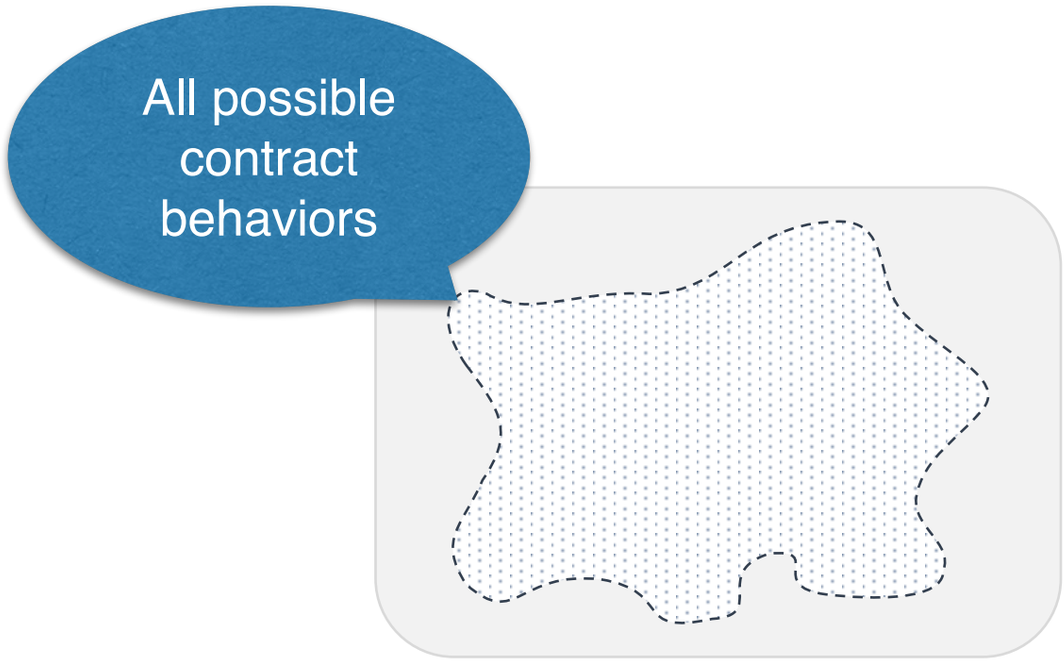

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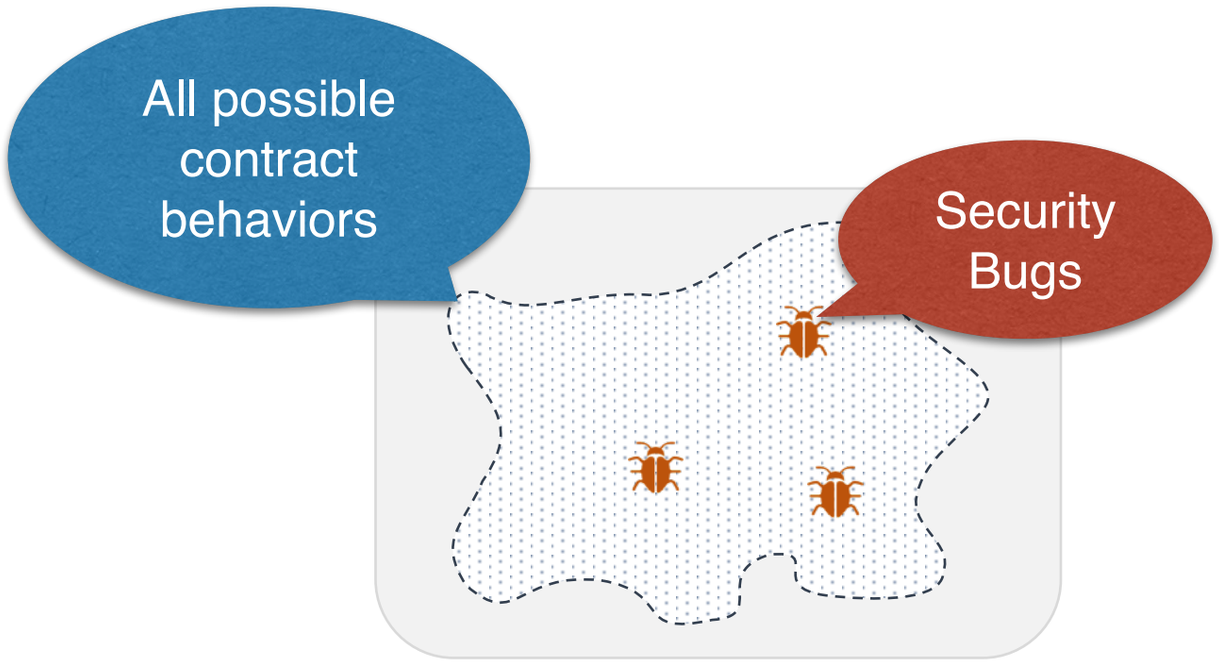

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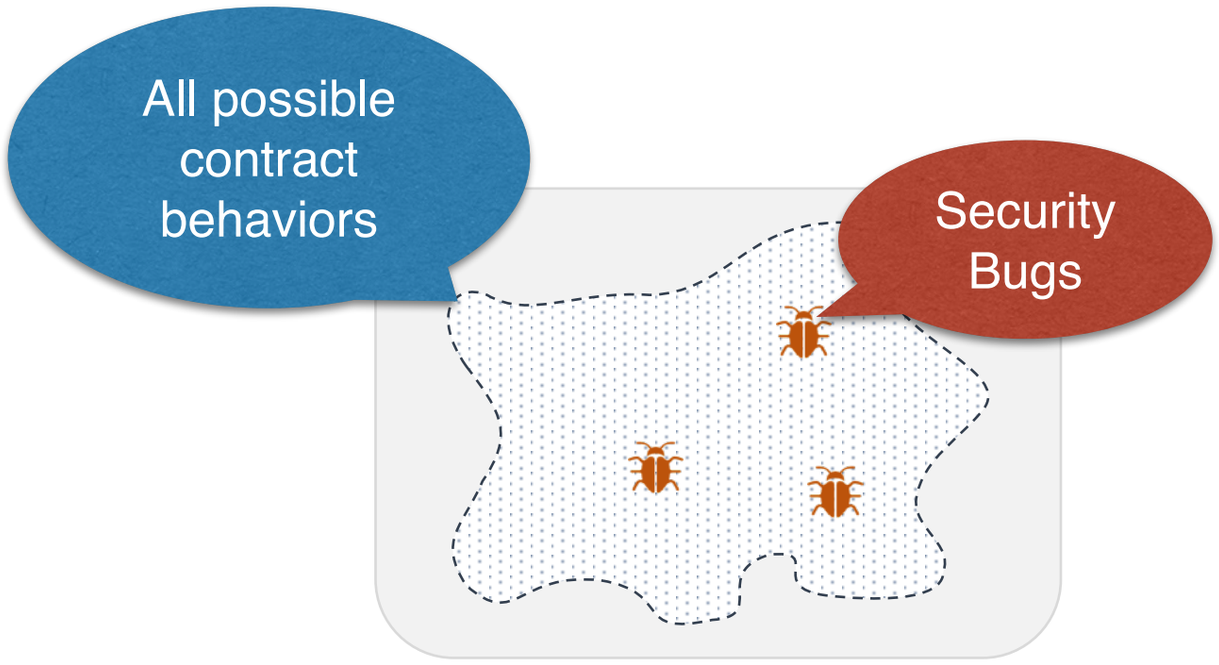

Problem: Cannot enumerate all possible contract behaviors…

Automated Security Analysis: Existing Solutions

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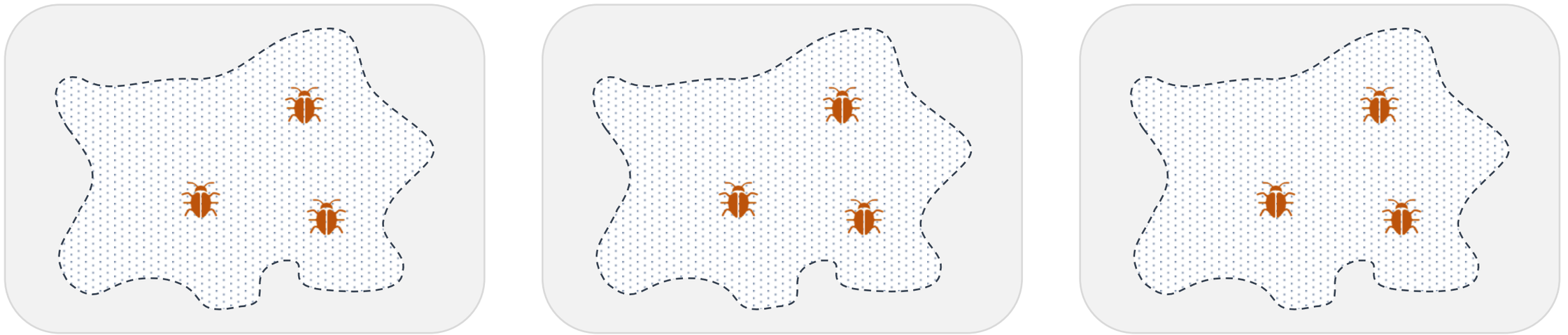

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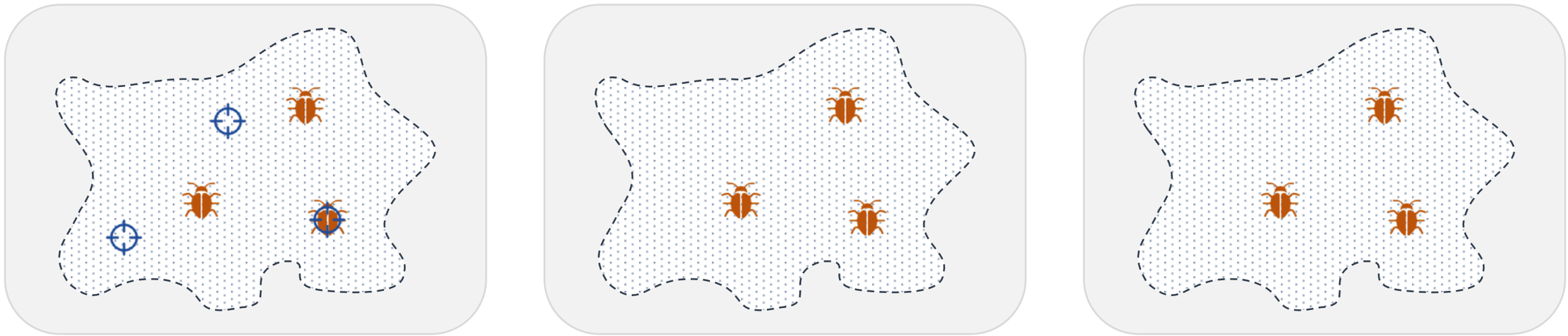

- Testing

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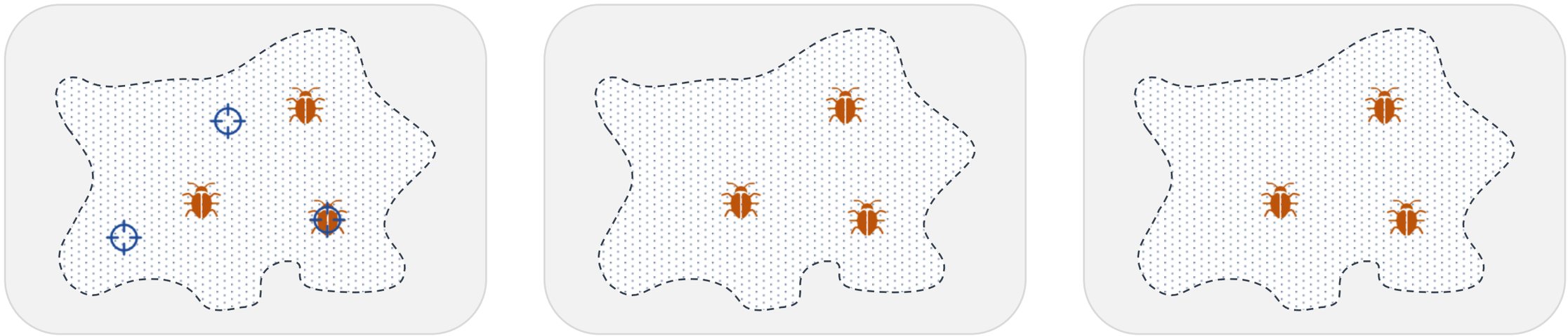

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  Very limited guarantees

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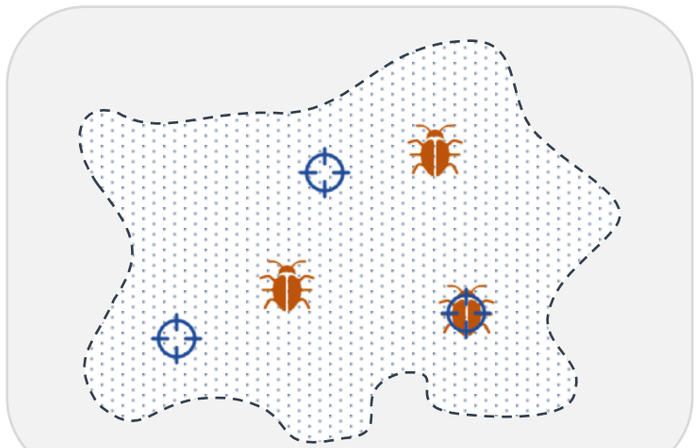

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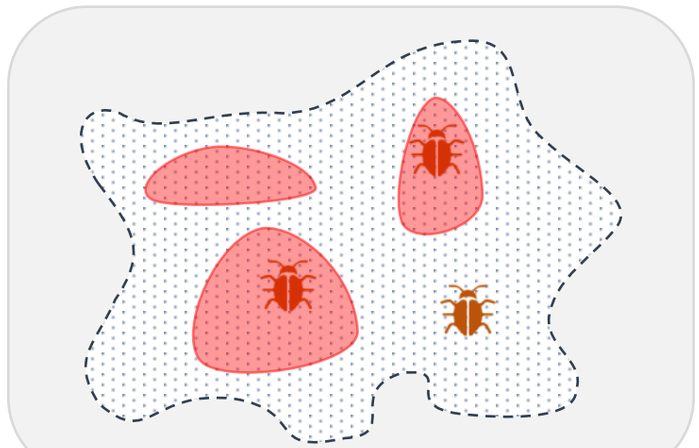
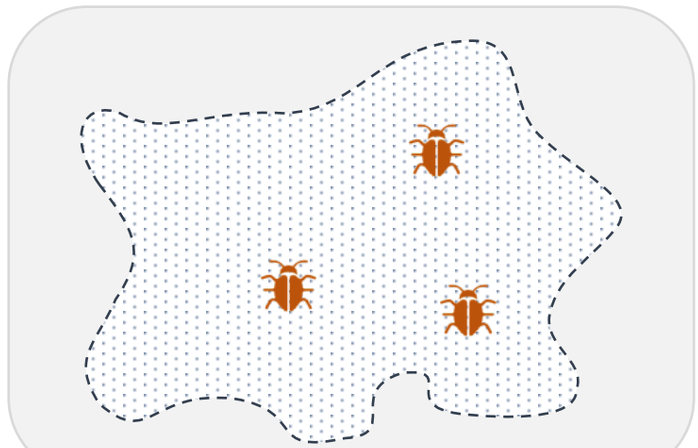


- Dynamic analysis
- Symbolic execution



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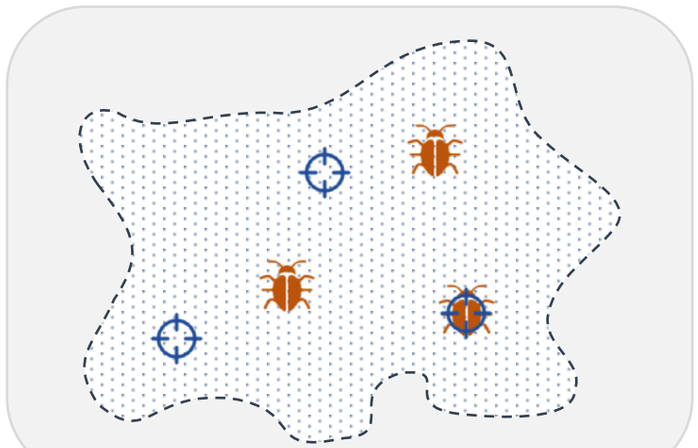

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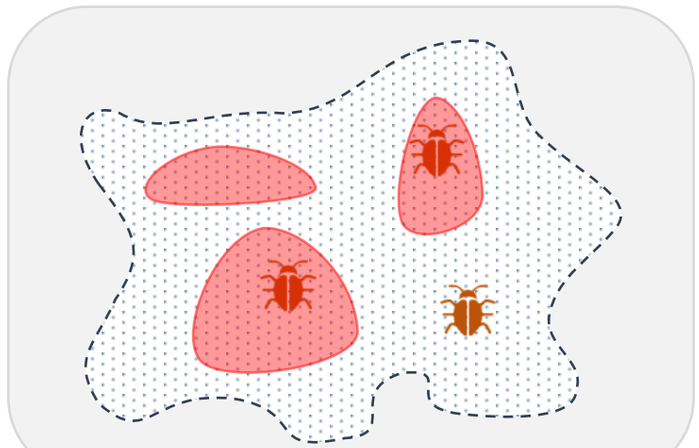

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Better than testing, but
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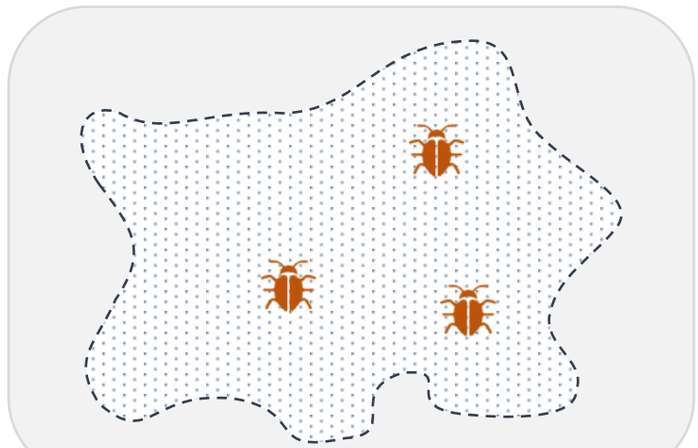

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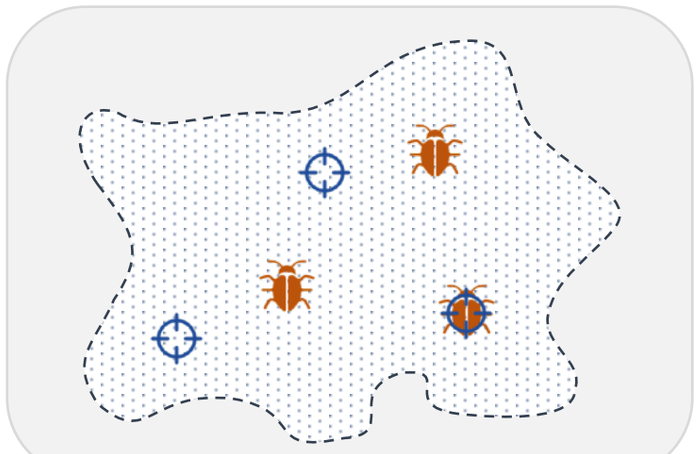

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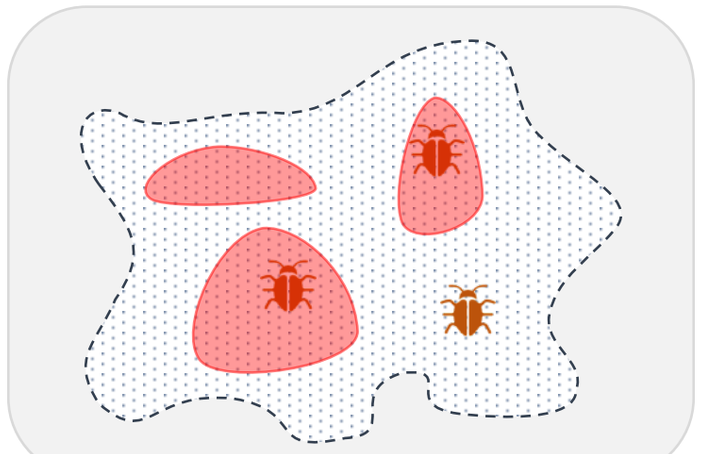

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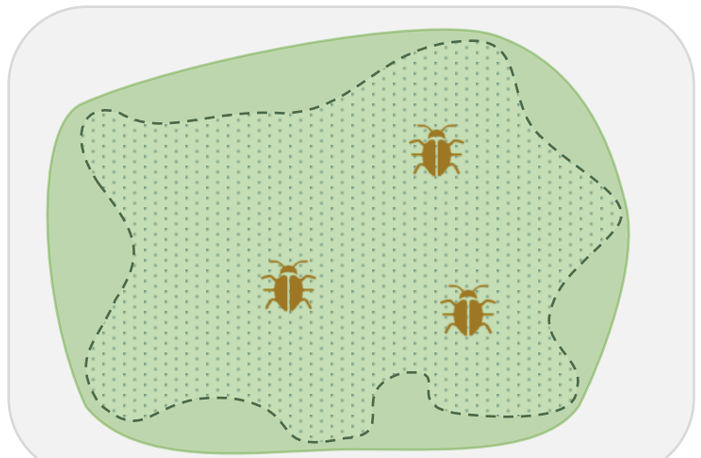

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- Formal verification

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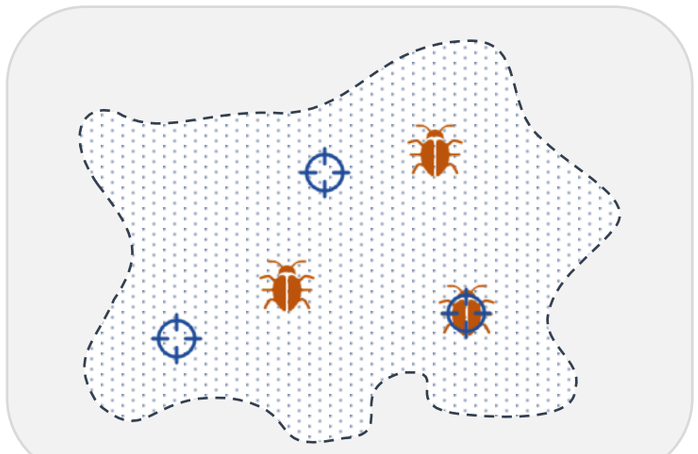

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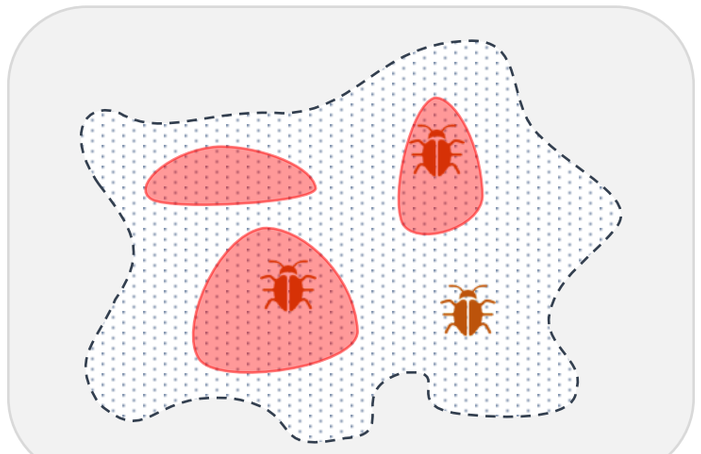

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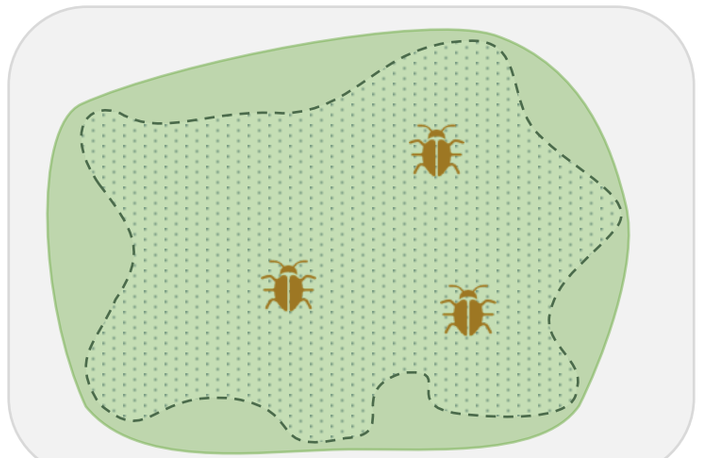

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Strong guarantees