Frontrunning in Ethereum

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Evaluation of vulnerability detection tools

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What do these tools have in common?

- Conkas
- Ethracer
- Mythril
- Oyente
- Securify

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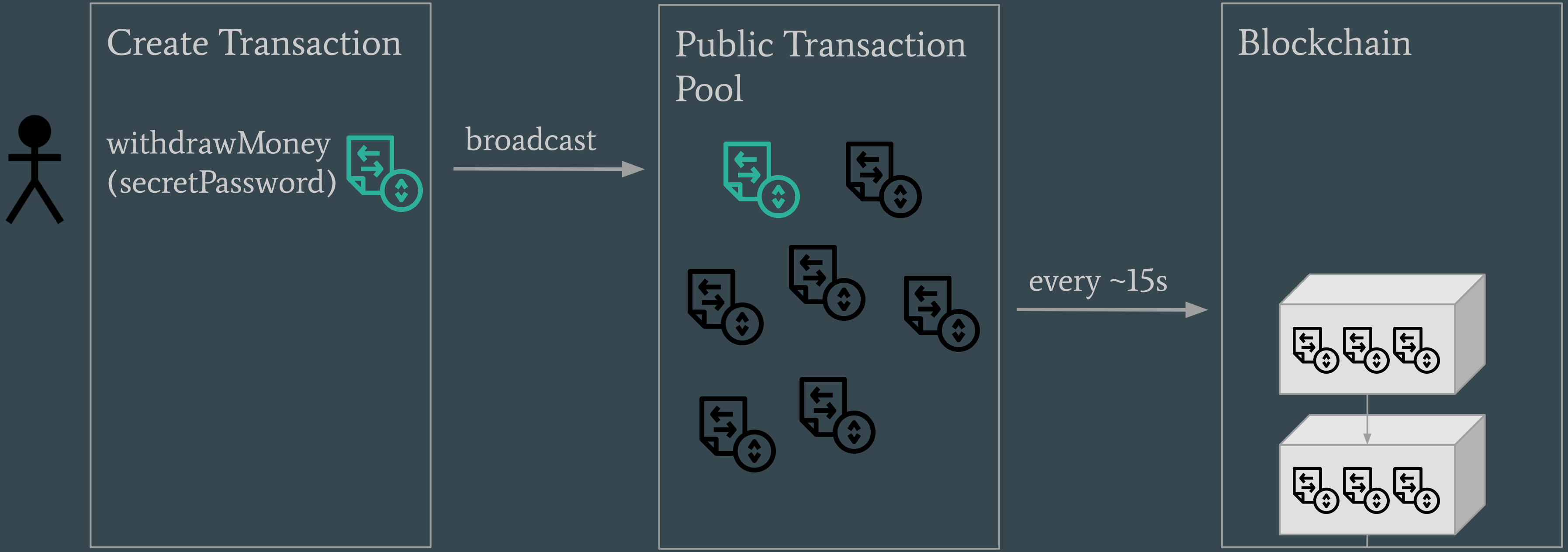
1. They can detect frontrunning vulnerabilities in programs
2. They all miss > 94% of vulnerable programs[1]

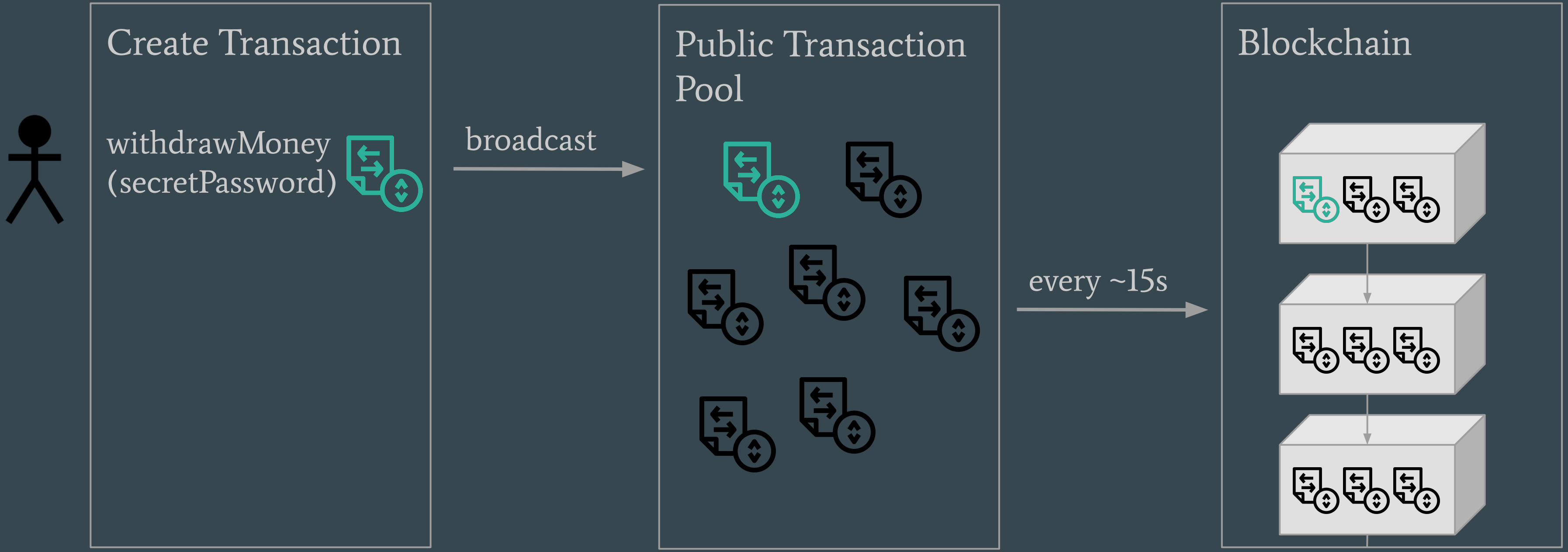
[1] Zhang et al. (2023) Combatting Front-Running in Smart Contracts: Attack Mining, Benchmark Construction and Vulnerability Detector Evaluation.

Why?

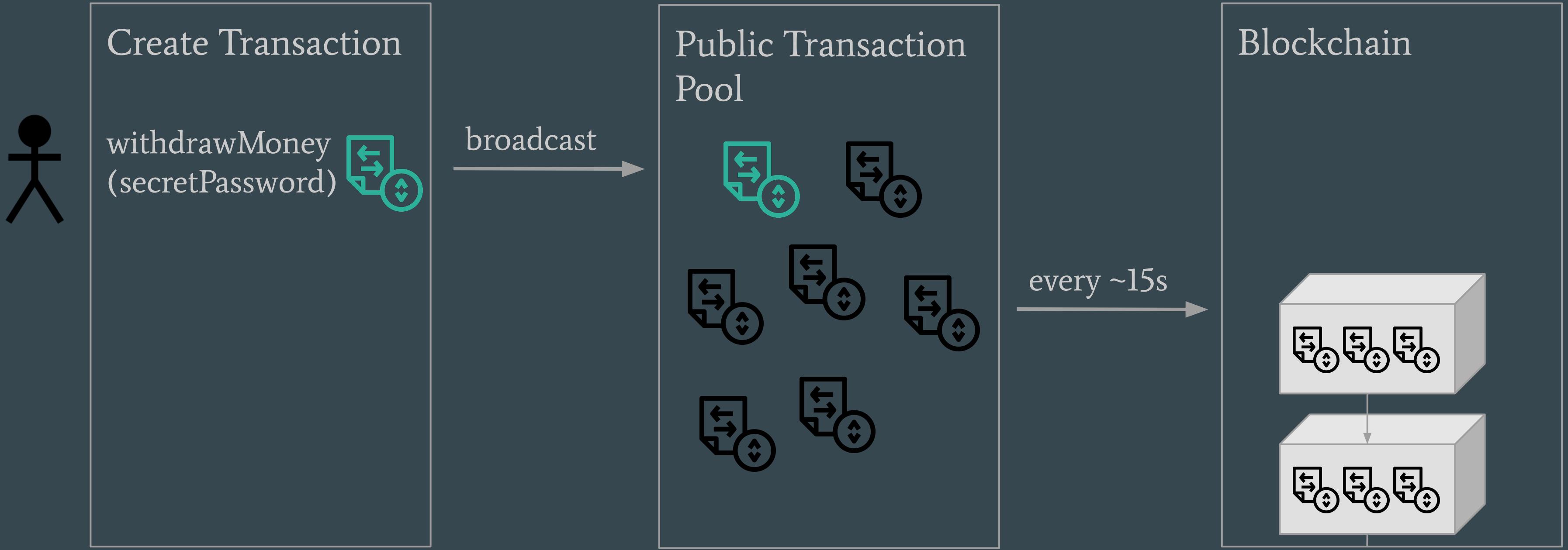
Ethereum Transactions



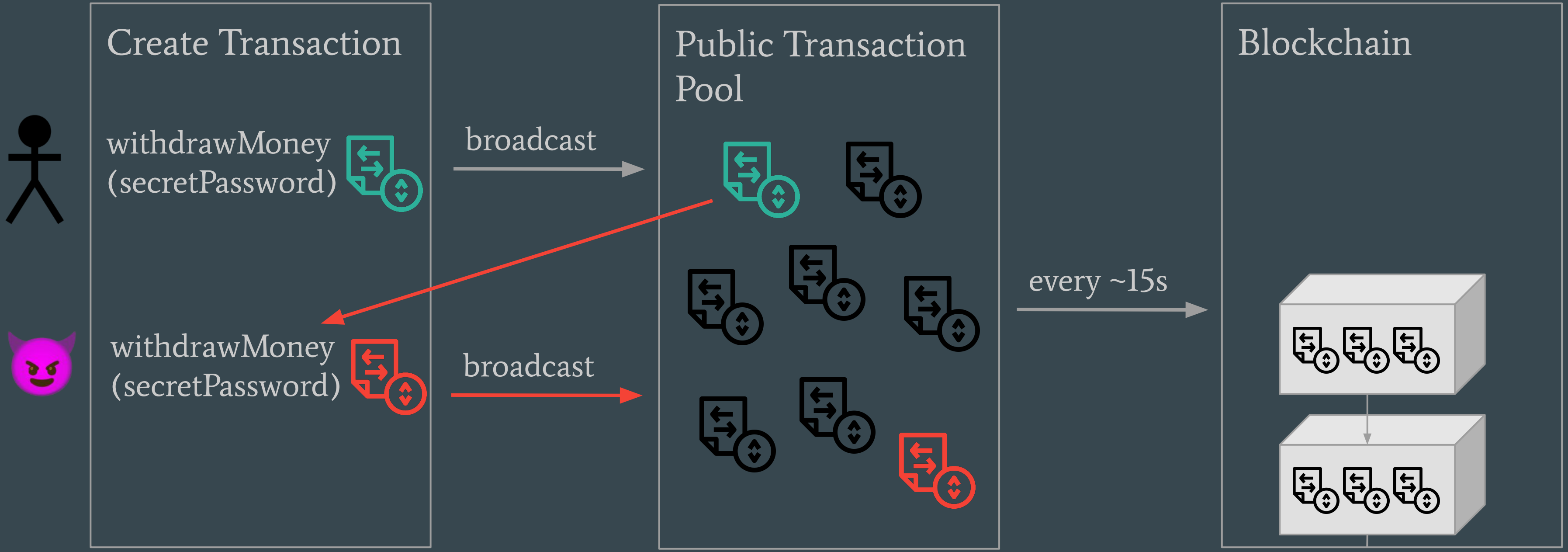
Ethereum Transactions



Frontrunning



Frontrunning



Create Transaction

withdrawMoney (secretPassword)

withdrawMoney (secretPassword)

broadcast

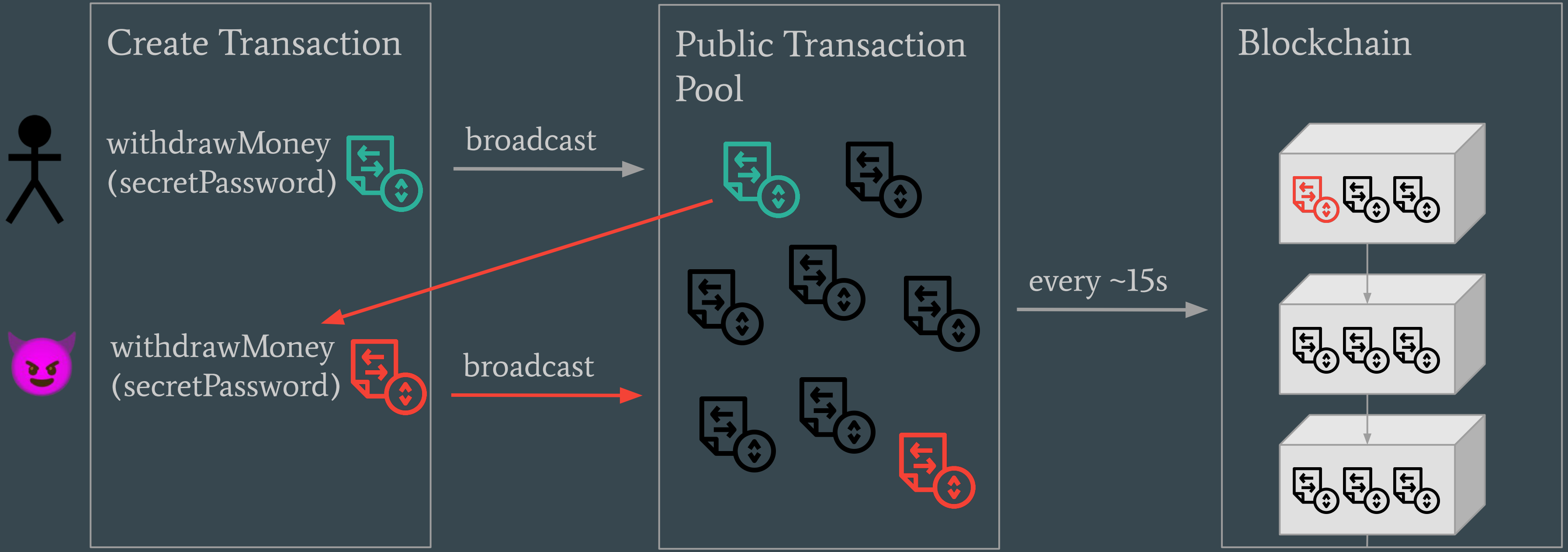
broadcast

Public Transaction Pool

every ~15s

Blockchain

Frontrunning



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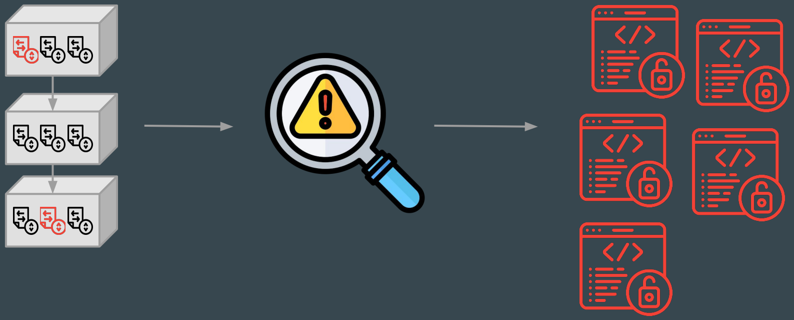
State of the Art

Why are frontrunning vulnerability detectors so bad?

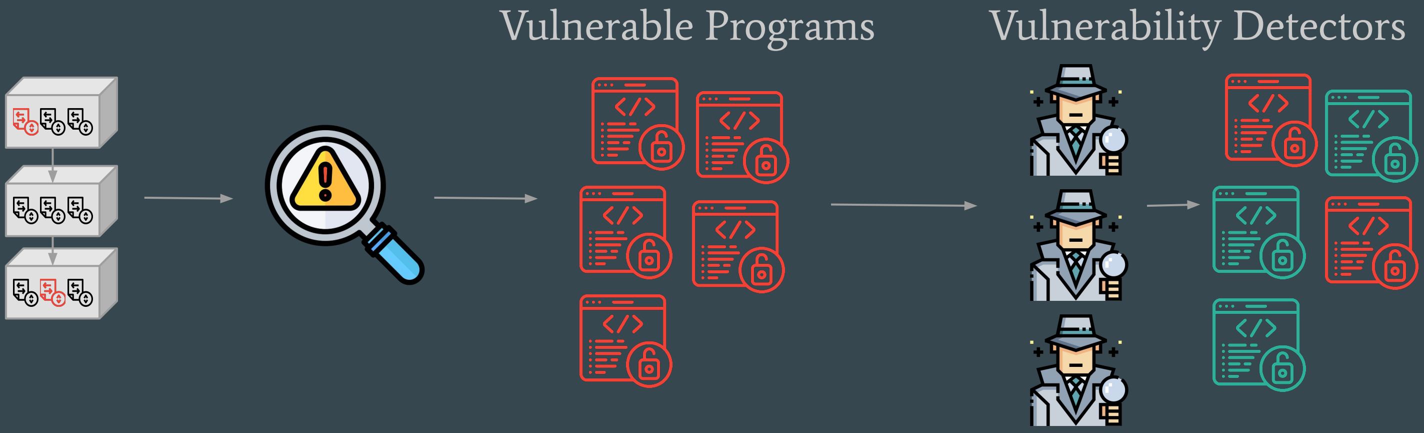
State of the Art



Vulnerable Programs

Zhang et al. (2023) Combatting Front-Running in Smart Contracts: Attack Mining, Benchmark Construction and Vulnerability Detector Evaluation.

State of the Art



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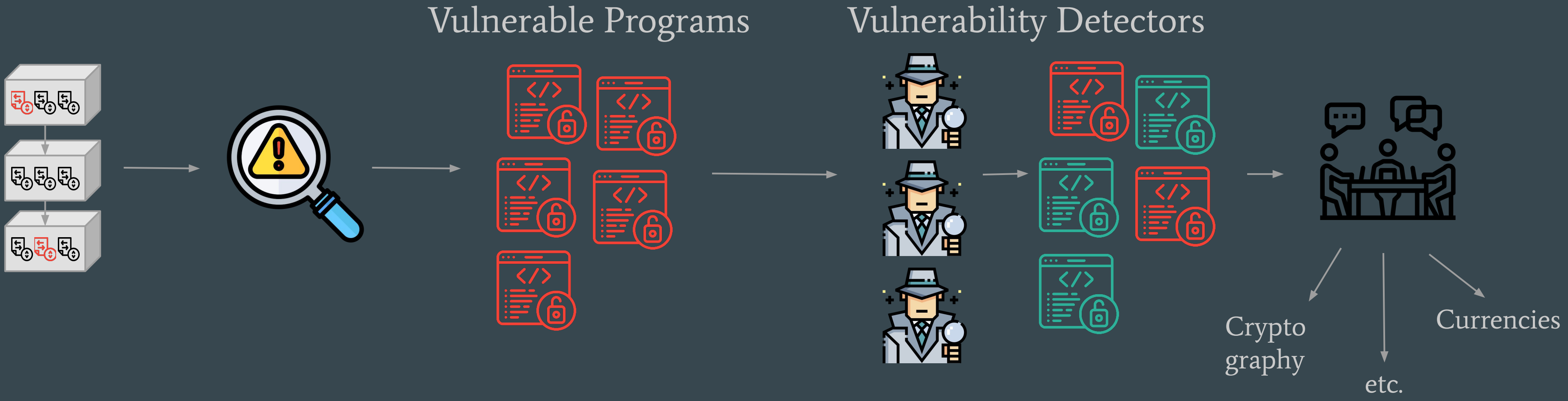

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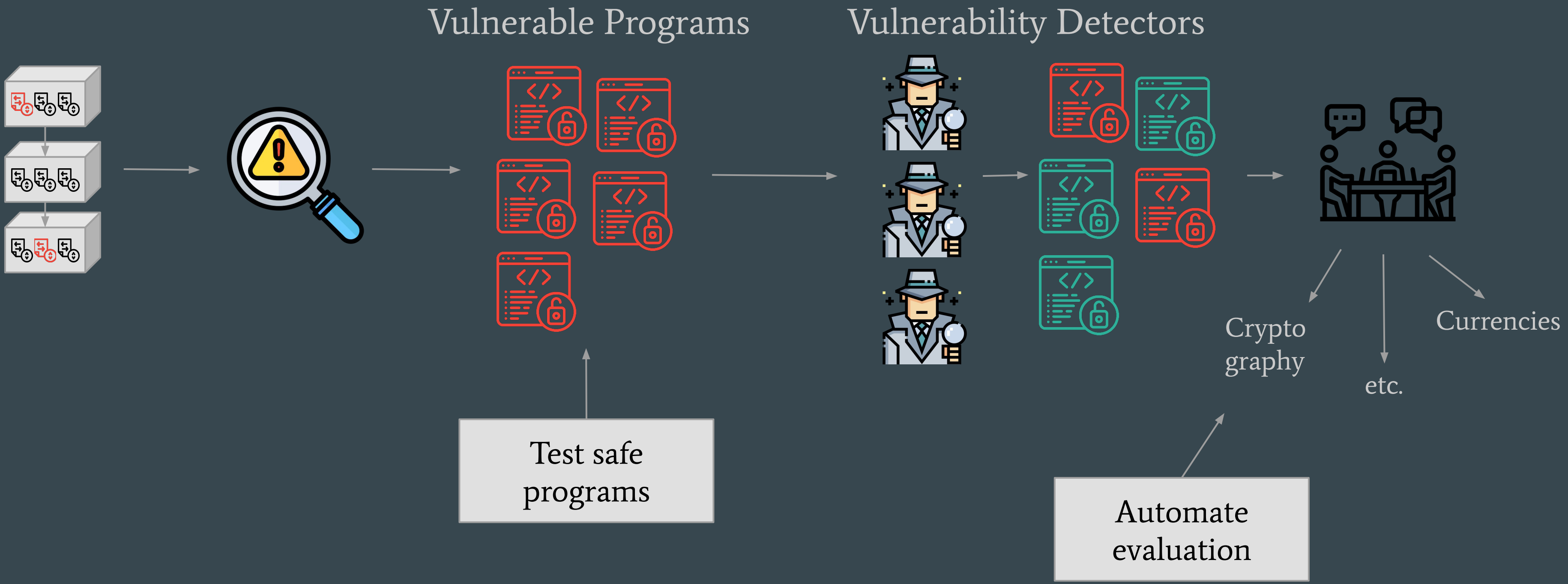


Vulnerable Programs

Vulnerability Detectors

Test safe programs

Automate evaluation

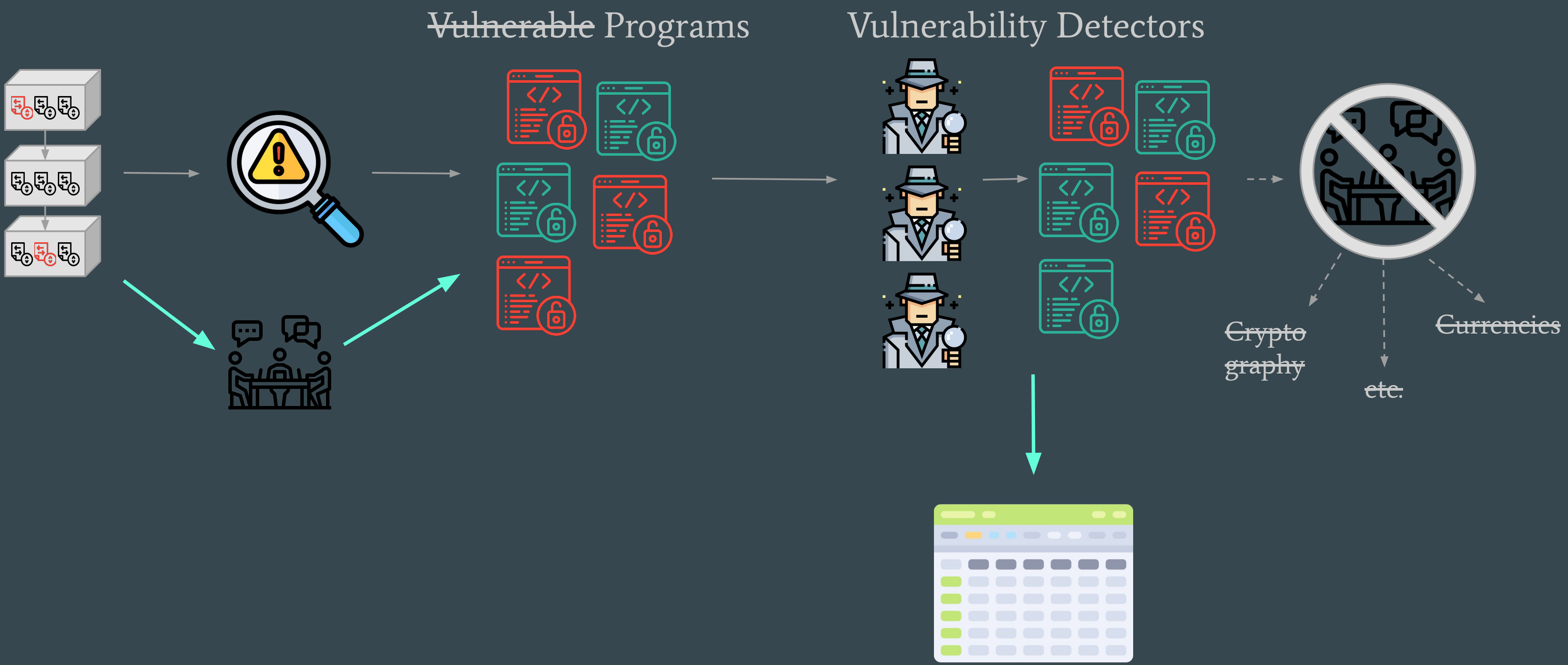
Crypto graphy

etc.

Currencies

Zhang et al. (2023) Combatting Front-Running in Smart Contracts: Attack Mining, Benchmark Construction and Vulnerability Detector Evaluation.

Add secure programs



~~Vulnerable~~ Programs

Vulnerability Detectors

~~Crypto graphy~~

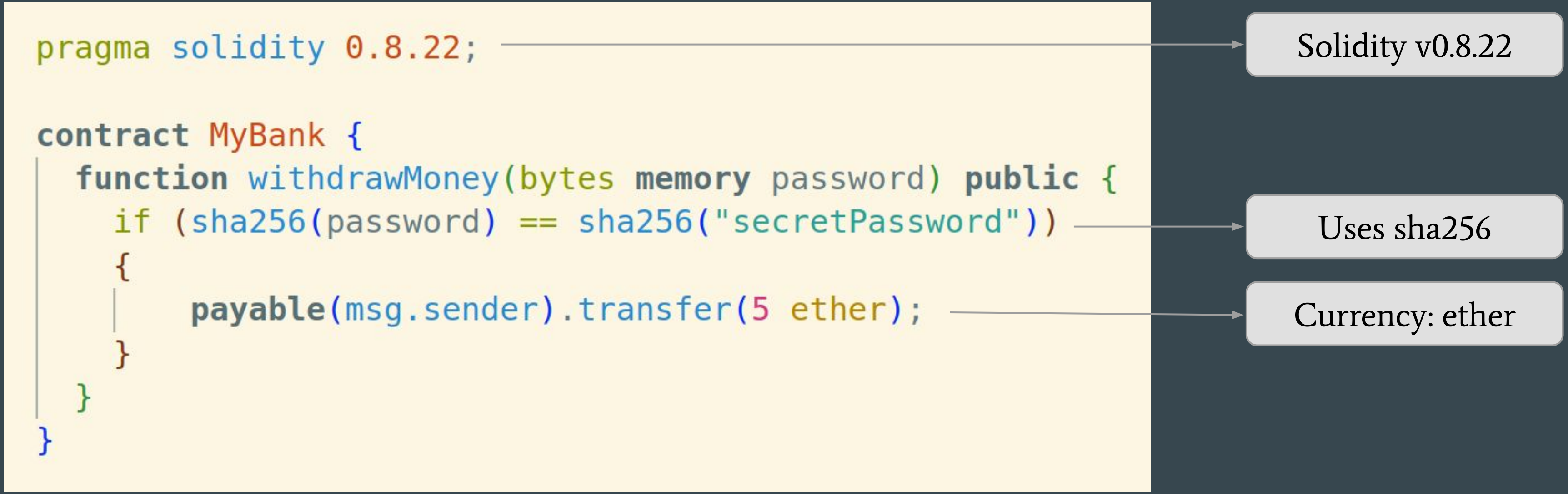
~~etc.~~

~~Currencies~~

Evaluation Example

Tool \ Secure?	Vulnerable Programs	Secure Programs
Conkas	20%	15%
Oyente	18%	8%
Securify	0%	20%

Label the programs!



```
pragma solidity 0.8.22;

contract MyBank {
  function withdrawMoney(bytes memory password) public {
    if (sha256(password) == sha256("secretPassword"))
    {
        payable(msg.sender).transfer(5 ether);
    }
  }
}
```

Solidity v0.8.22

Uses sha256

Currency: ether

Evaluation Example

Tool \ Label	Uses sha256	Currency: ether	Currency: Token
Conkas	0%	15%	0%
Oyente	18%	8%	14%
Securify	0%	20%	12%

Contributions

- Verification of previous results
- Detailed understanding of causes for missed vulnerabilities
- Dataset for reproducible & automatic tool evaluation
- First analysis of false positives

References & Credits

[1] Wuqi Zhang, Lili Wei, Shing-Chi Cheung, Yepang Liu, Shuqing Li, Lu Liu, and Michael R. Lyu. Combatting Front-Running in Smart Contracts: Attack Mining, Benchmark Construction and Vulnerability Detector Evaluation. In IEEE Transactions on Software Engineering, volume 49, pages 3630–3646, 2023.

Icons from Flaticon:

- Transaction
- Investigation
- Source Code
- Investigator
- Coworking
- Stats Table
- Check
- Nope Shield