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AI-Driven Smart Contract Vulnerability Detection

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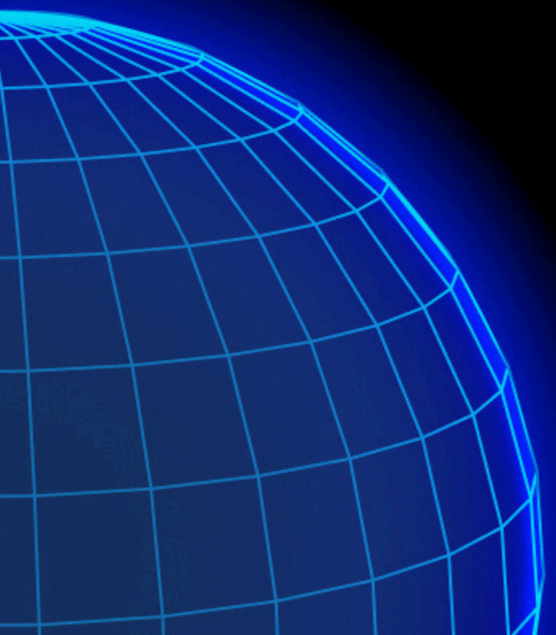

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Who am I

- Product Development Lead @OneSavie Lab
- Member @DeFiHackLabs
- Focus on AI & Web3 Development

Daky

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Who am I

- Security Research Engineer @OneSavie Lab
- OP and White Hat @DeFiHackLabs
- Audit Team member @TaiChi Audit Group
- Focus on Web3 Security Research

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Let's make web3 more secure!

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Agenda

01 Background

02 About Bastet

- Introduction
- Methodology

03 Conclusion

Background

What is DeFi ?

- Decentralized Finance(DeFi)
- Including lending, derivatives, decentralized exchanges, asset management, stablecoin, insurance, borrowing, etc.

Motivation: Driving Industry Security

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- DeFi applications are becoming more diverse, with increasing security awareness and service demand. Together, we aim to promote industry development through the power of the community.

- Expecting to optimize the process from test to audit.

As a white hat in competitive auditing platforms ...

- When I see a new codebase, many attack vectors come to mind.
- However, many common bugs still frequently appear in codebases, even up until now.

The goal of code review

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- When we conduct code reviews, our goal is to focus on enhancing security coverage.
- Identifying all problematic code snippets, and writing detailed reports for these bugs.

They are just like your BFF

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Type	Checklist
AMM	hardcoded slippage? deadline check? arbitrary calls? ...
Lending	Self-liquidation? Can prevent liquidation? User can repay? ...
EIP Compliant	EIP-4626 Rounding issues ? ERC-5095 return check? EIP-2981 able to pay correct amounts of royalties

The execution of project is time-limited

- Within limited resources, the most important one is time.
- Focus on high-quality findings.

Test -> Audit


Development
Test
Incident Response
Audit
Continuous Monitoring

Common Smart Contract Analysis Tool

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- Mostly static analysis tools
- Rules are maintained using AST or Regex

Automated Findings / Publicly Known Issues

The 4naly3er report can be found here.

About Bastet

Introduction

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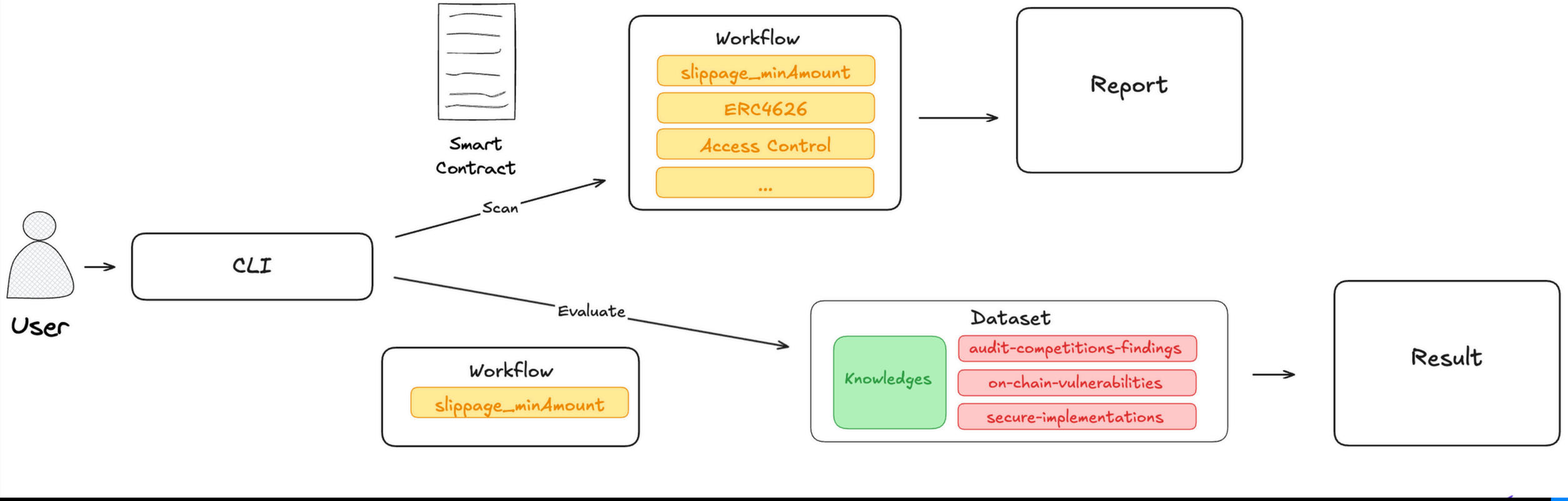
- This open source project Bastet focus on two parts:
  - Vulnerability dataset + AI Audit benchmark tool
  - AI Vulnerability identification process

User Scenario



How to Select Targets ?

- The vulnerability selection focuses on common issues that are hard to maintain with static analyzers.
- Designing processes to enhance AI's accuracy in detecting vulnerabilities.

Methodology

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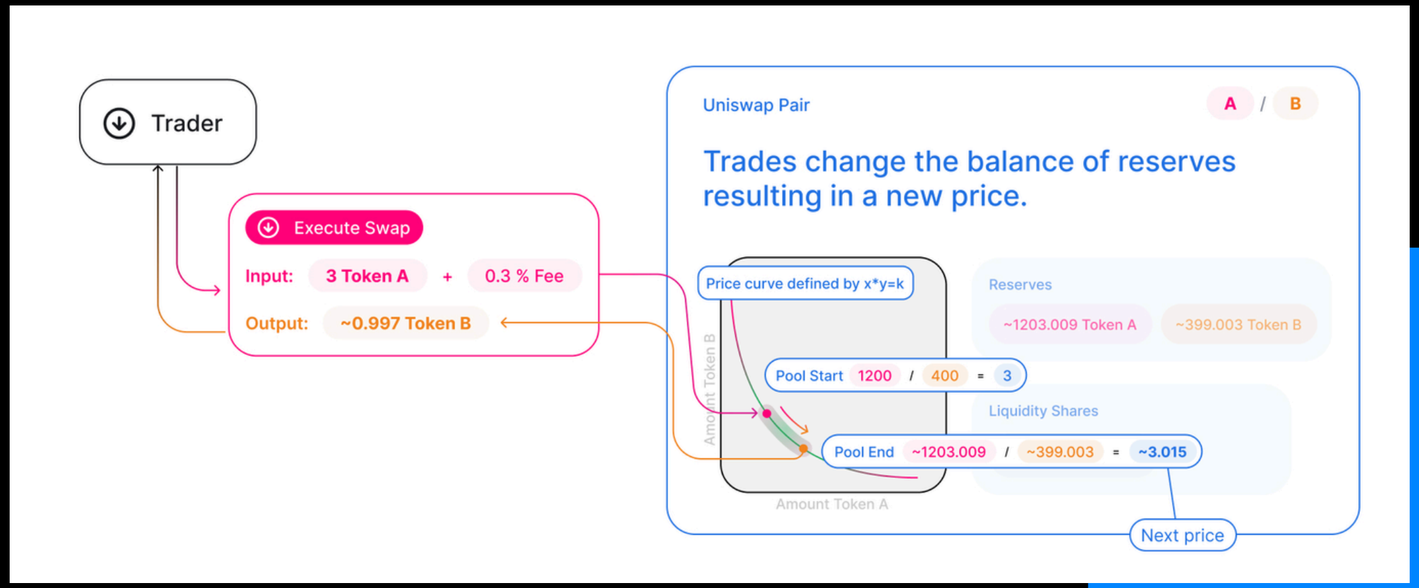
- What we need to prepare
  - Knowledges
  - Prompt Engineering Technique
  - Validation

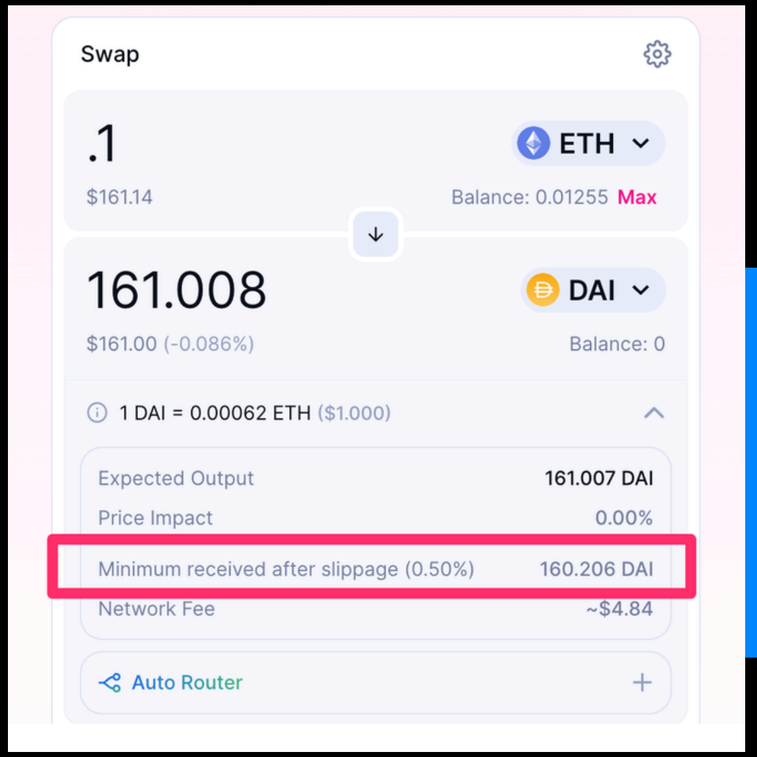
Knowledges - Uniswap

- Uniswap is an automated liquidity protocol powered by a constant product formula (x*y=k).



Knowledges - Slippage

- Slippage refers to the difference between the **expected price** of a transaction and the **actual price** at which the transaction is executed.



Knowledges - Slippage

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- If there is no slippage check, MEV can monitor transactions and perform a **sandwich attack** before and after the transaction, profiting from the price fluctuations.

How to perform detection using static analyzers?

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01 Use **findAll** to search for specific functions like **addLiquidity.**

02 Find the location of parameters like **minAmountOut** in the function.

03 Write corresponding conditional checks for each type of improper slippage setting scenario.

What are the challenges of doing this?

- There are variations in the function names for swaps and slippage parameters across different protocols.
- The same issues cannot be detected in different programming languages.

What method are we using?

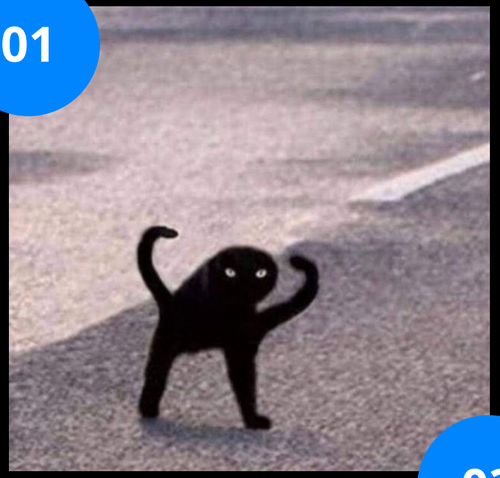
- Example, human brain learns to recognize cats

- Knowledge Base:
  - A cat's appearance typically features **soft fur** and **a sleek, agile body**.
  - They have **four legs**, with **sharp claws** that are perfect for climbing and hunting.
  - Cats' **ears are upright**, and their **noses are small and sensitive**.
  - A cat's **tail is long and flexible**, often used to maintain balance.




AI Might Think ...

01



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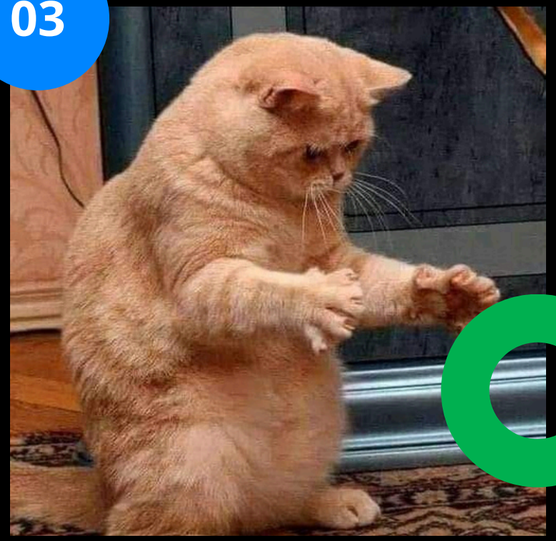

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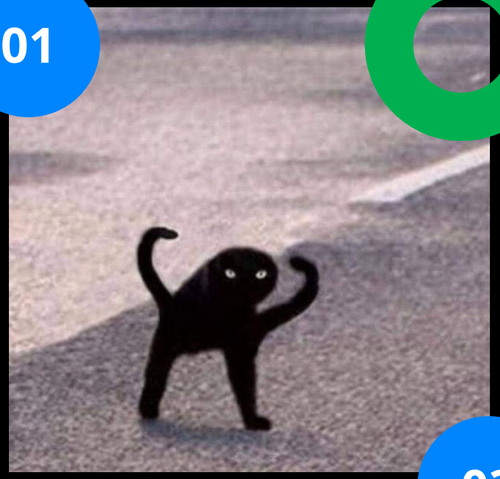
The Answer

01



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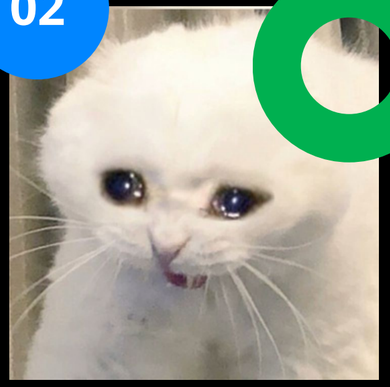

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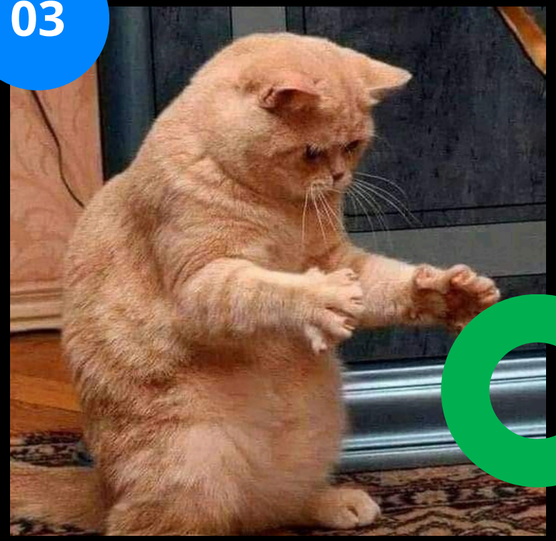

04

05

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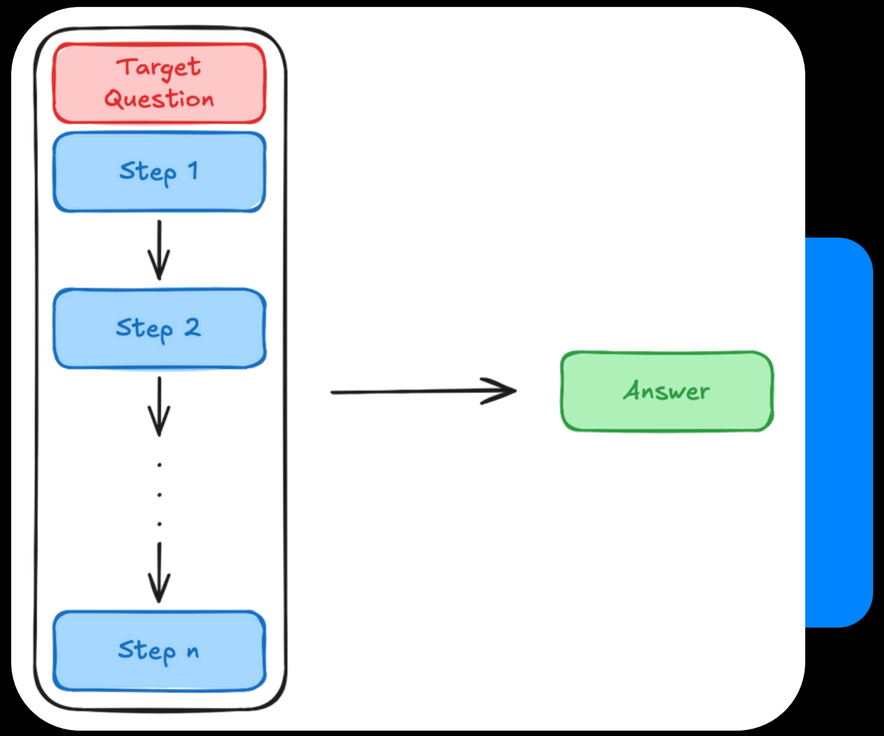
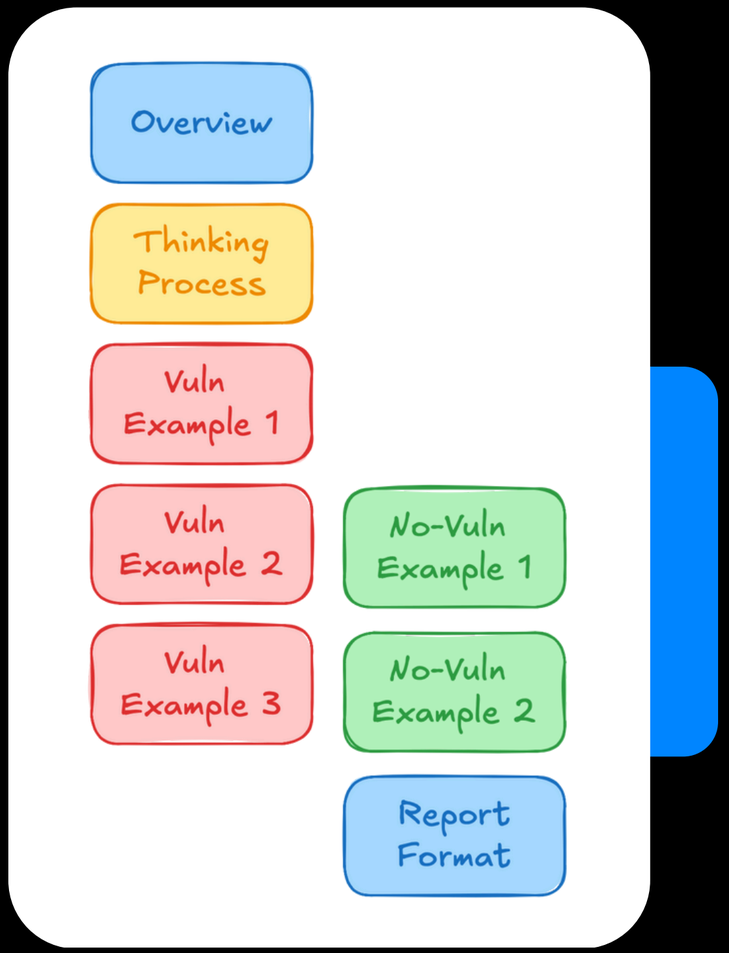
Prompt Engineering Technique – CoT

- By using the CoT method, the reasoning ability of large language models can be improved.
- By breaking down the reasoning process, we help the model think step-by-step, with each step closely tied to the root causes of vulnerabilities.



Prompt Engineering Technique – CoT

- The LLM analyzes each function according to the specified steps.
- The LLM details the thought process in the examples.
- Generate results based on the report format.



Bastet's Output

- Summary
- Severity
- Vulnerability Details
  - Description
  - Code Snippet
- Recommendation

Bastet Security Report

Missing Slippage Protection for Token Swap

Severity: High

Vulnerability Details

- **File Name:** `IbbtcVaultZap.sol`
- **Function Name:** `deposit`
- **Description:**
  The function uses `add_liquidity` from the `CURVE_IBBTC_DEPOSIT_ZAP` contract without specifying a minimum amount of LP tokens to receive.
  This exposes the user to potential slippage, which could result in receiving fewer tokens than expected due to price fluctuations.

Code Snippet

```
uint256 vaultDepositAmount = ICurveZap(CURVE_IBBTC_DEPOSIT_ZAP).add_liquidity(
    CURVE_IBBTC_METAPOOL,
    depositAmounts,
    0,
    address(this)
);
```

Recommendation

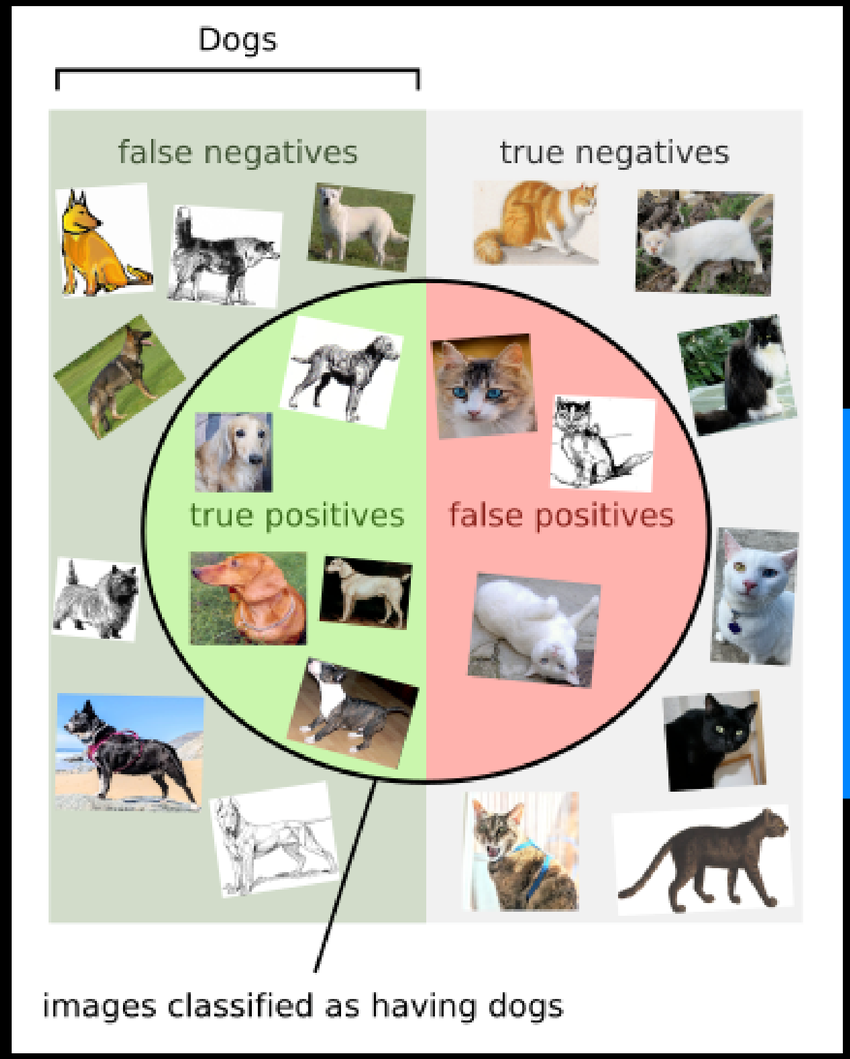
Introduce a parameter for the minimum amount of LP tokens to receive (e.g., _minAmountOut) and use this parameter in the add_liquidity function to ensure slippage protection.

Test Results - example

- Accuracy
  - How to calculate?

$$\text{Accuracy} = \frac{\text{correct classifications}}{\text{total classifications}}$$

$$= \frac{TP + TN}{TP + TN + FP + FN}$$



Bastet Eval Results

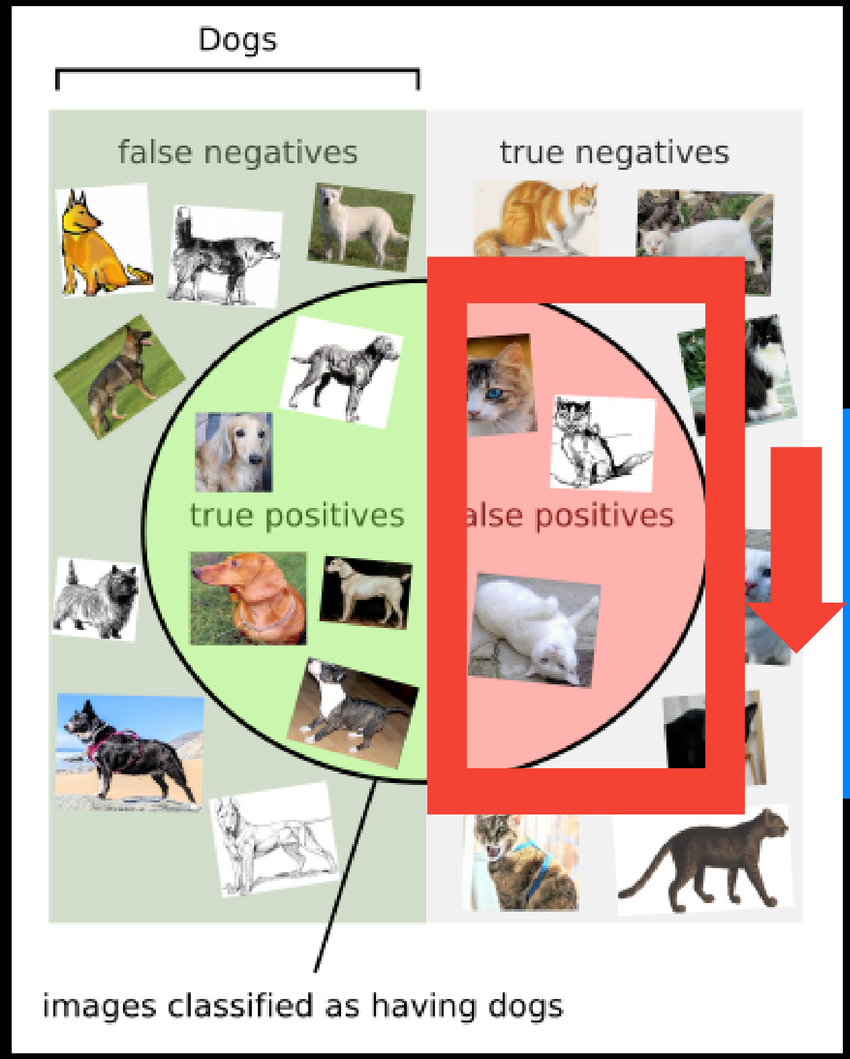
- The evaluation result of minAmountOut workflow is
  - True Positive: 12
  - True Negative: 27
  - False Positive: 2
  - False Negative: 5

- Accuracy: (12+27)/46 = 84.7%

Metric	Value
True Positive	12
True Negative	27
False Positive	2
False Negative	5

Bastet Test Results

- High Accuracy is good
- Less False Positive (FP) is good
- Save Developer and Researcher's Time



Can Bastet One Day Replace Human Researchers?

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- The goal of Bastet is to assist researchers to focus on higher level issues such as systemic risks, logic errors, integration issues, and more.
- As a tool, it will undoubtedly become stronger over time.

What Does Bastet Need To Become Stronger?

- Data
- Knowledge Base
- Methodology

What if the vulnerabilities that are not in the knowledge base?

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- Bastet is highly skilled at finding details and implementation errors in code.
- We are also working closely with the community.
- Bastet has already identified **valid** findings in every audit, including **high** and **medium** severity issues.

Conclusion

Takeaway

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- Bastet features:
  - Dataset + Evaluation
  - AI workflows

DeFiHackLabs Time

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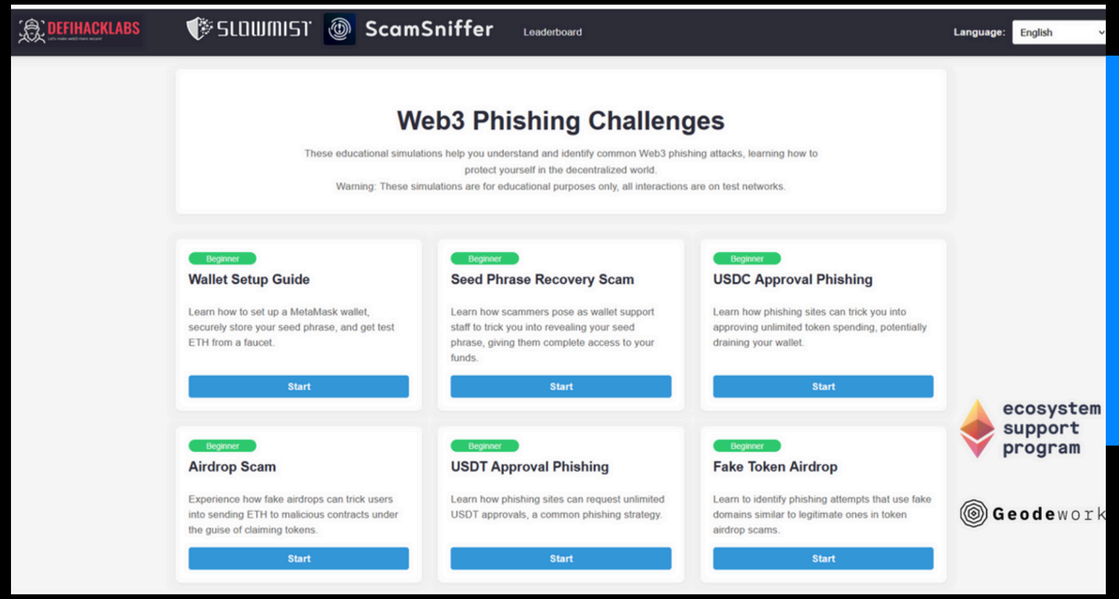
- PhishQuest: Interactive Web3 Anti-Phishing Training Platform
- Founding Contributors: DeFiHackLabs、SlowMist、ScamSniffer
- Supported by: Ethereum Foundation Grant
- Current Status: Prototype
- Features:
  - Gamification Design
  - 30+ Challenges
  - Community Collaboration
- Release: Before July



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Special Thanks

We are inspired by the spirit of community, open source, and selflessness, and hope to gather collective intelligence.

Together Strong!!!

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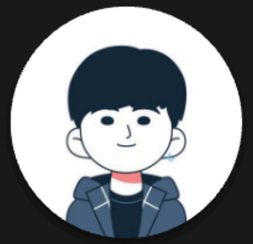
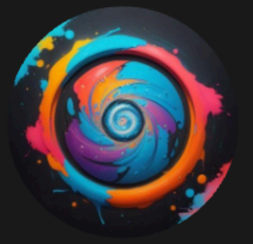
Let's make web3 more secure!

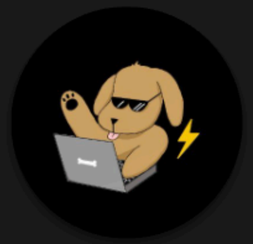



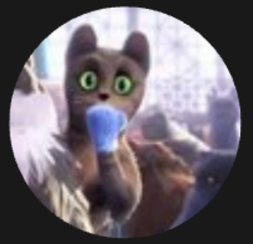










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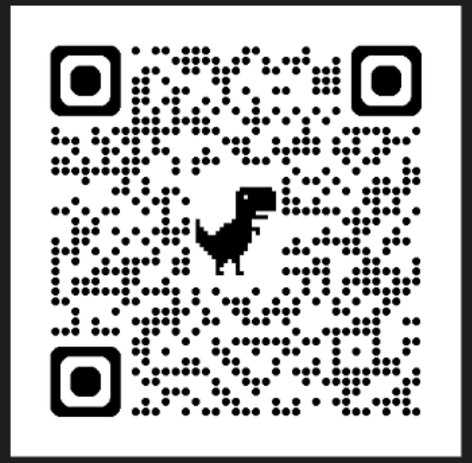

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Lab


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