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HELMHOLTZ CENTER FOR
INFORMATION SECURITY

YuraScanner: Leveraging LLMs for Task-driven Web App Scanning

*Aleksei Stafeev, **Tim Recktenwald**, Gianluca De Stefano, Soheil Khodayari, Giancarlo Pellegrino*

Network and Distributed System Security Symposium | 2025

Motivation

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- However, traditional approaches struggle with exploring deeper states

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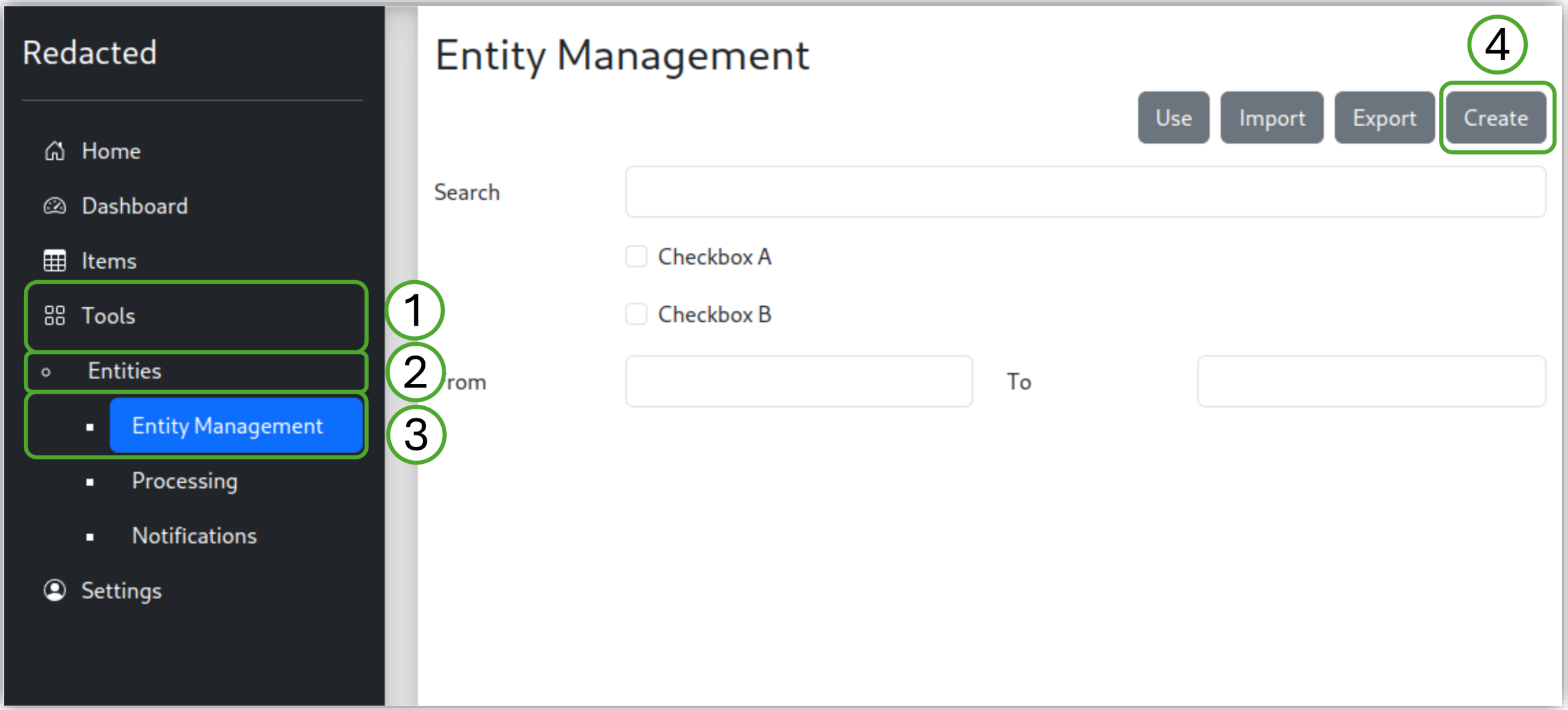
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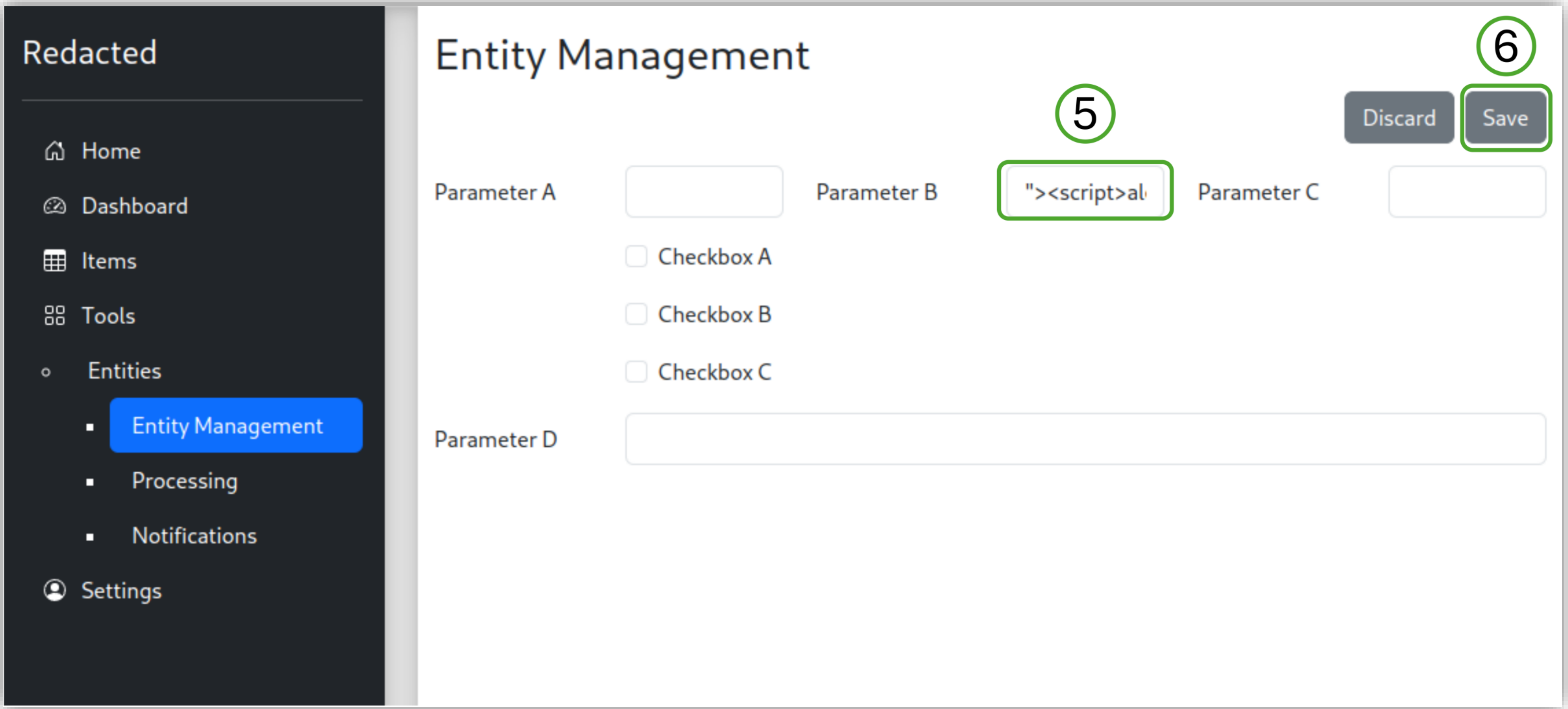
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- **Does not scale well!**

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- We propose a fully automated, task-driven web application scanner called YuraScanner

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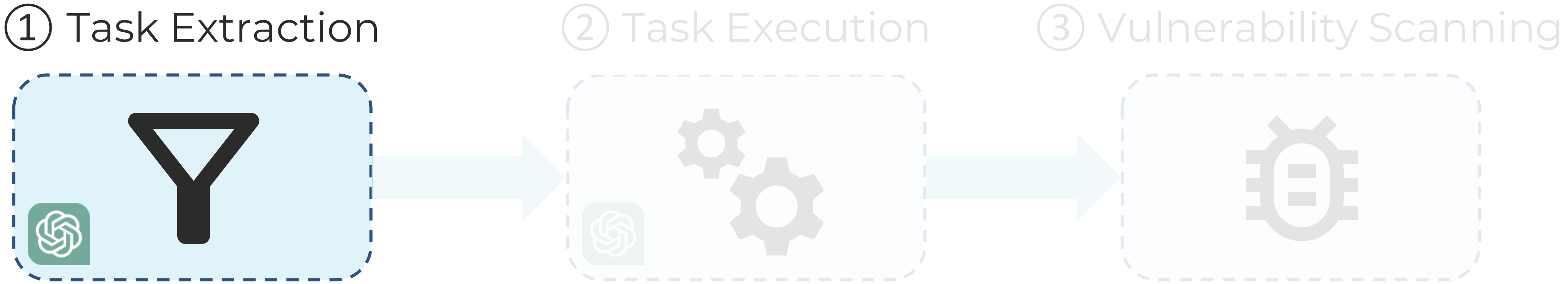
Architecture of YuraScanner



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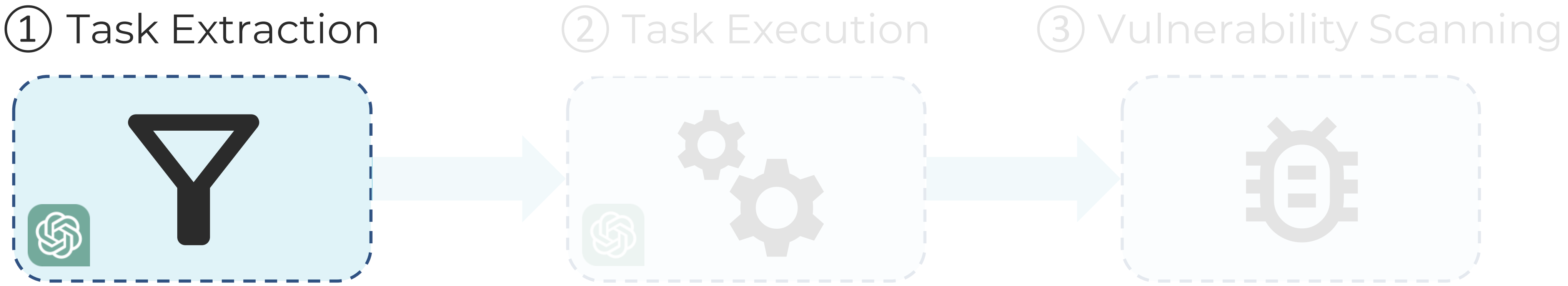
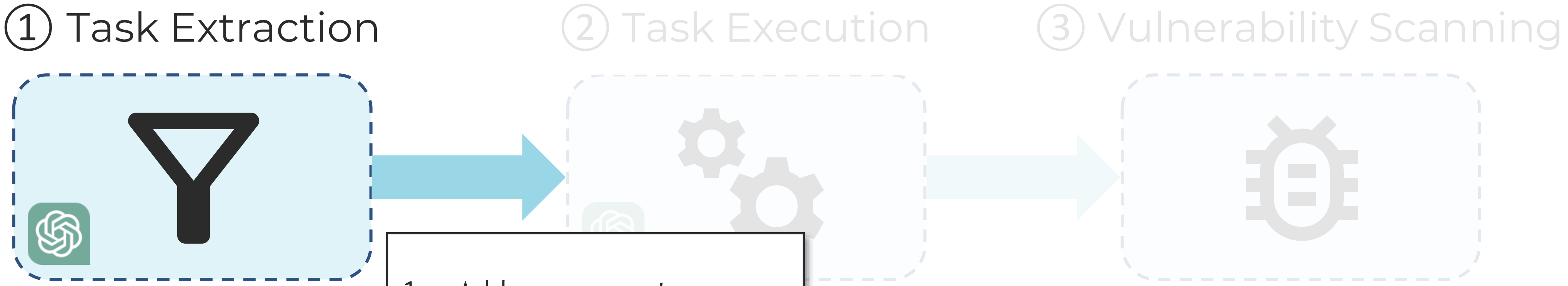


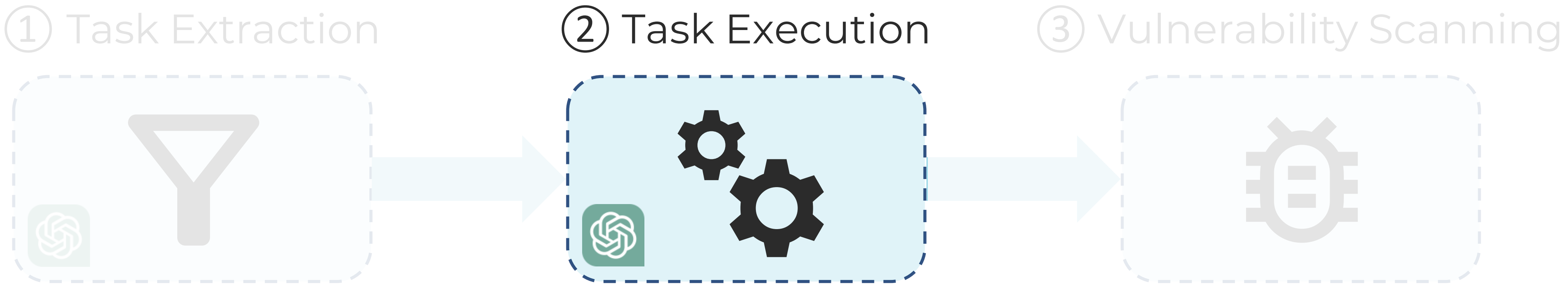
1. Shallow crawl of depth one
2. Extract text content from interactable HTML elements
3. Ask LLM to provide appropriate tasks

Architecture of YuraScanner



1. Add a new category for products.
2. Edit the information for an existing product.
3. Delete a previous order.

Architecture of YuraScanner



- Executes every task in multiple steps

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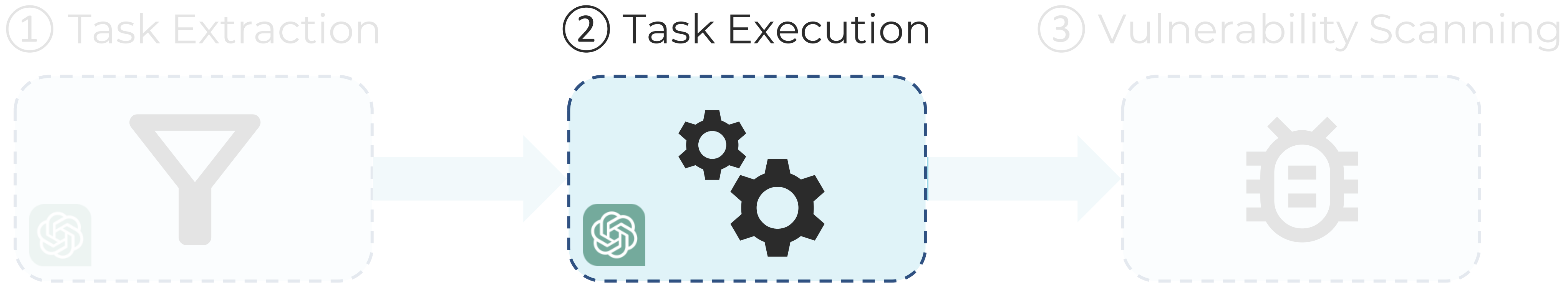

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  - Generate simplified textual page representation
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  - Execute command

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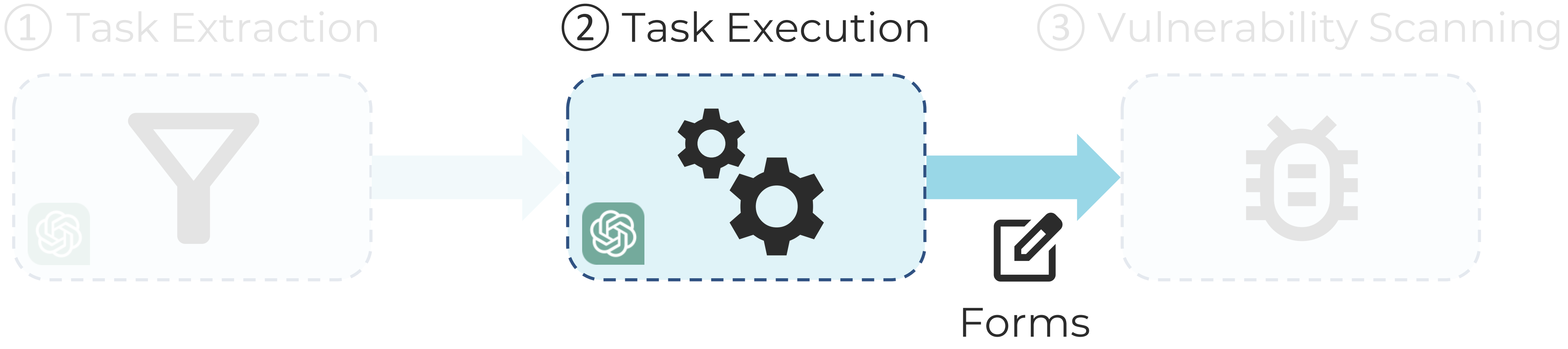

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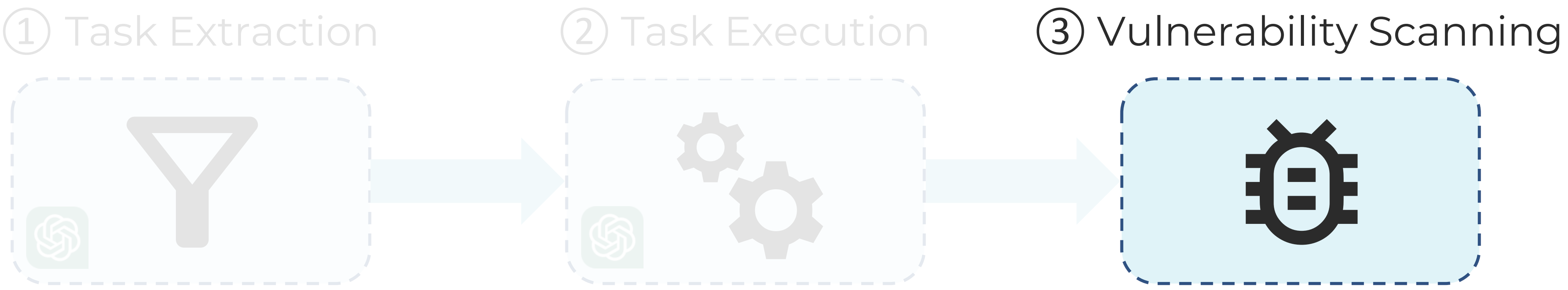

- We integrated the XSS engine of Black Widow
- Visits every form collected during task execution
- Injects predefined XSS payloads into input fields

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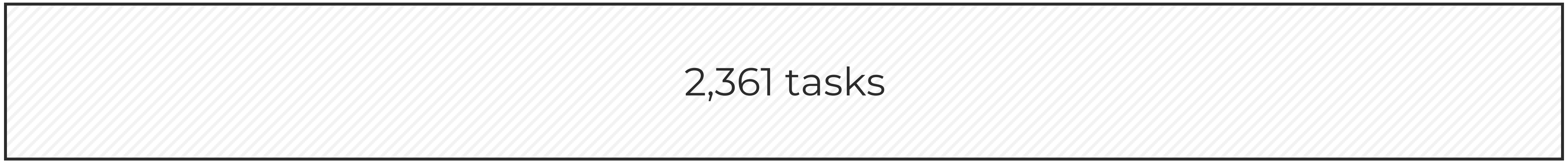
     – Random subset of 10 web apps
  2. **Vulnerability Detection**
     – Inspection of vulnerabilities found by the attack component
     – All 20 web apps

Evaluation Results: Task Extraction



- 2,361 tasks were generated in total across 10 web applications

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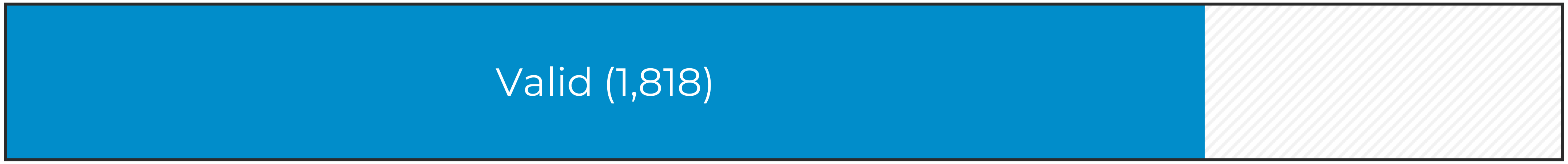

- 2,361 tasks were generated in total across 10 web applications
- 77% of the tasks were valid (1,818 tasks)

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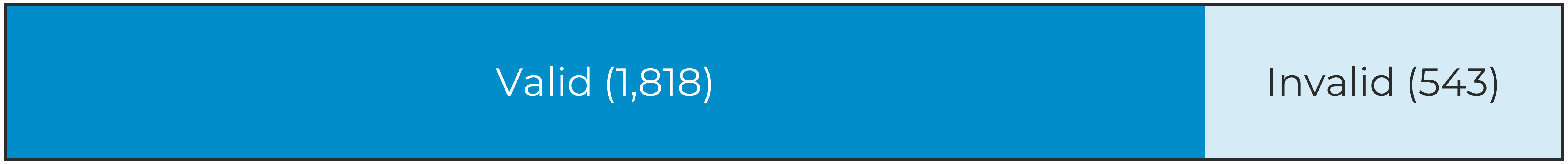
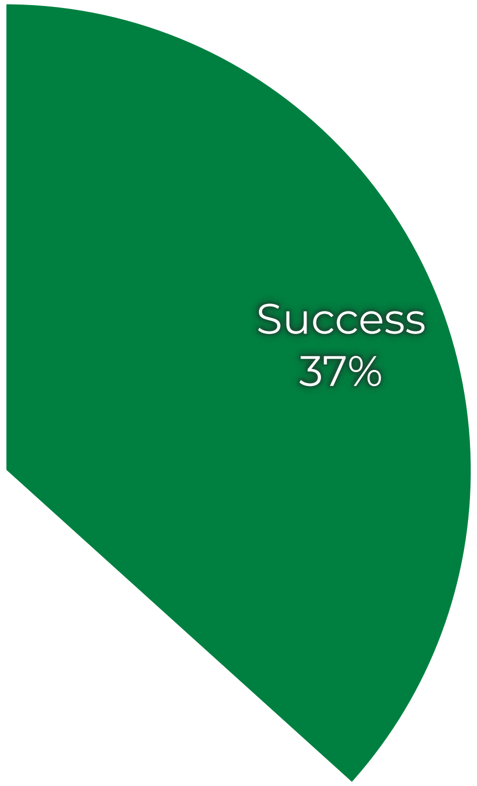


- 2,361 tasks were generated in total across 10 web applications
- 77% of the tasks were valid (1,818 tasks)
- "Invalid" = Functionality does not exist in the web application
- Invalid task generation mainly occurred on pages with insufficient context
  - E.g., login page with only one button

Evaluation Results: Task Execution



Task Execution Classification
(1,818 valid tasks)

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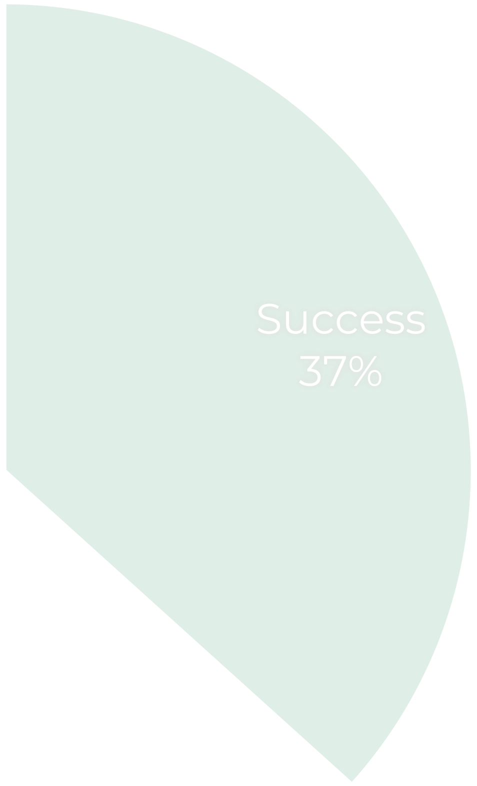

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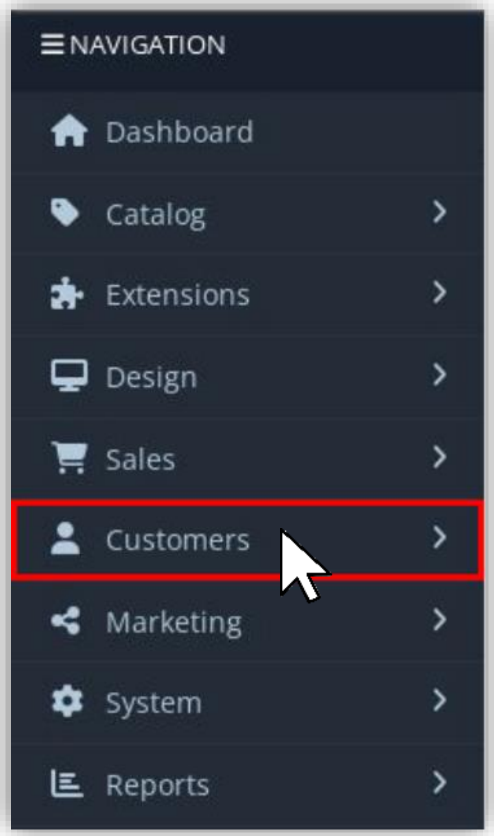
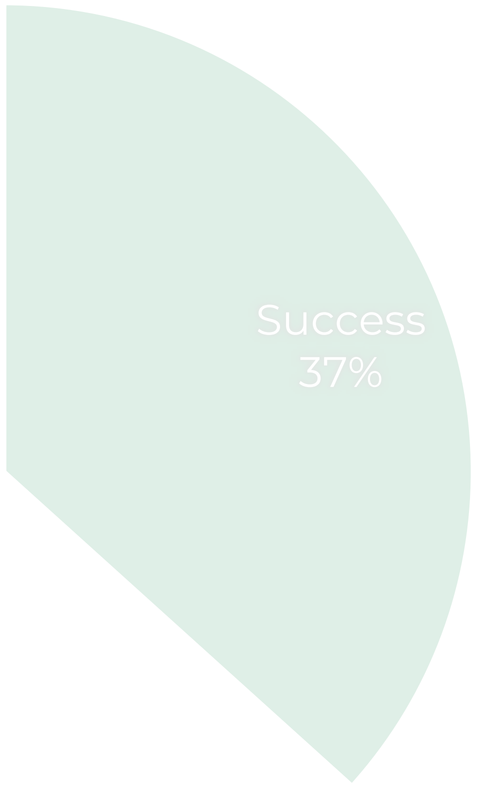


Task: Add new “Customers” to the database

Evaluation Results: Task Execution



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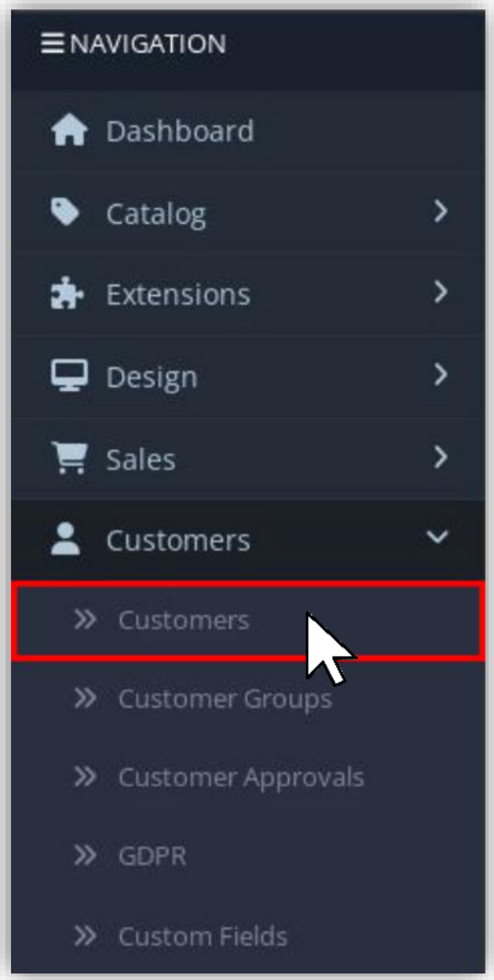

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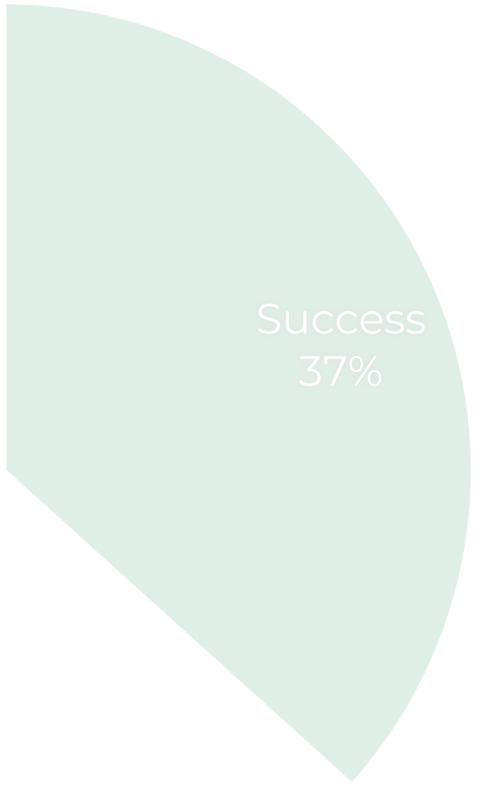

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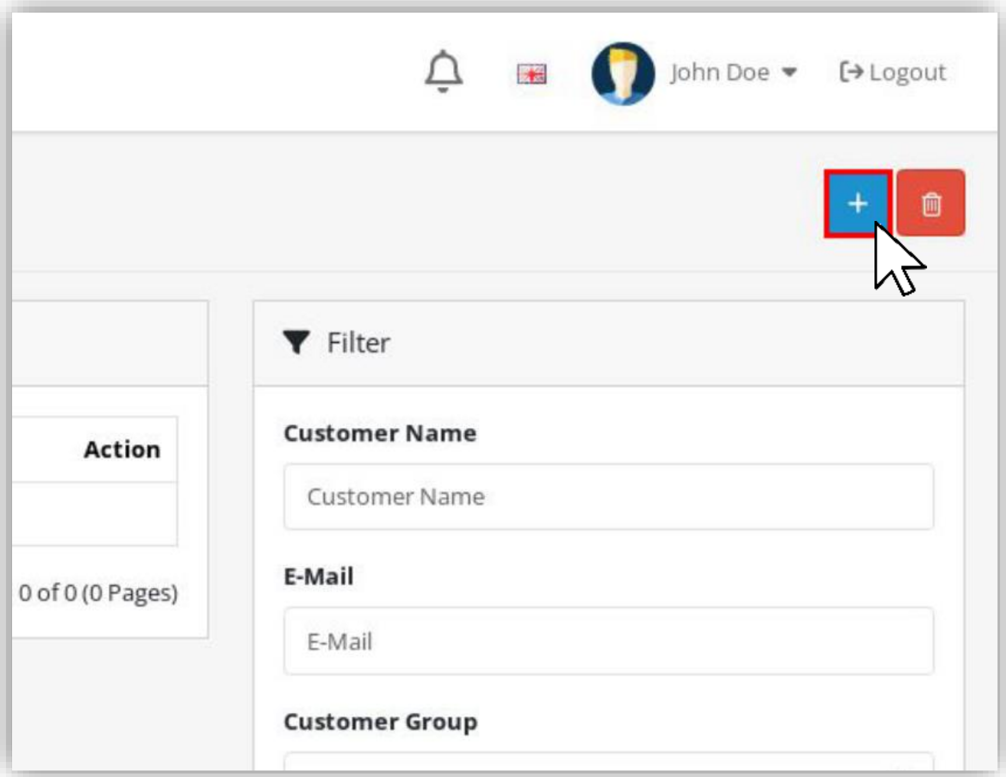

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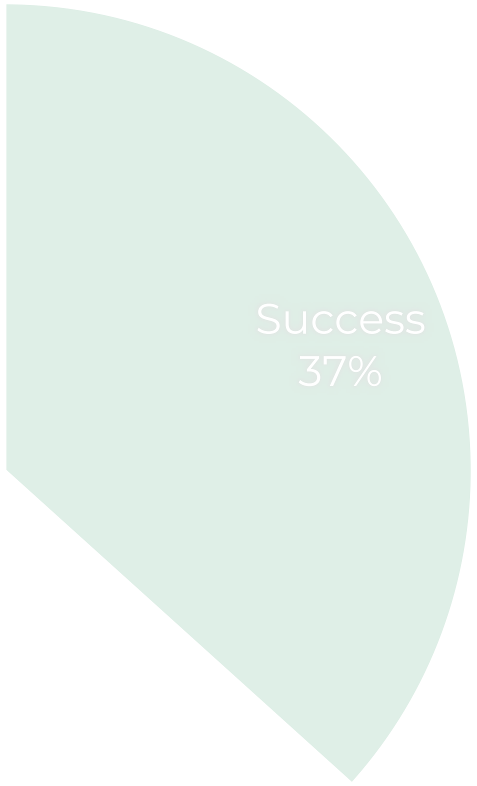

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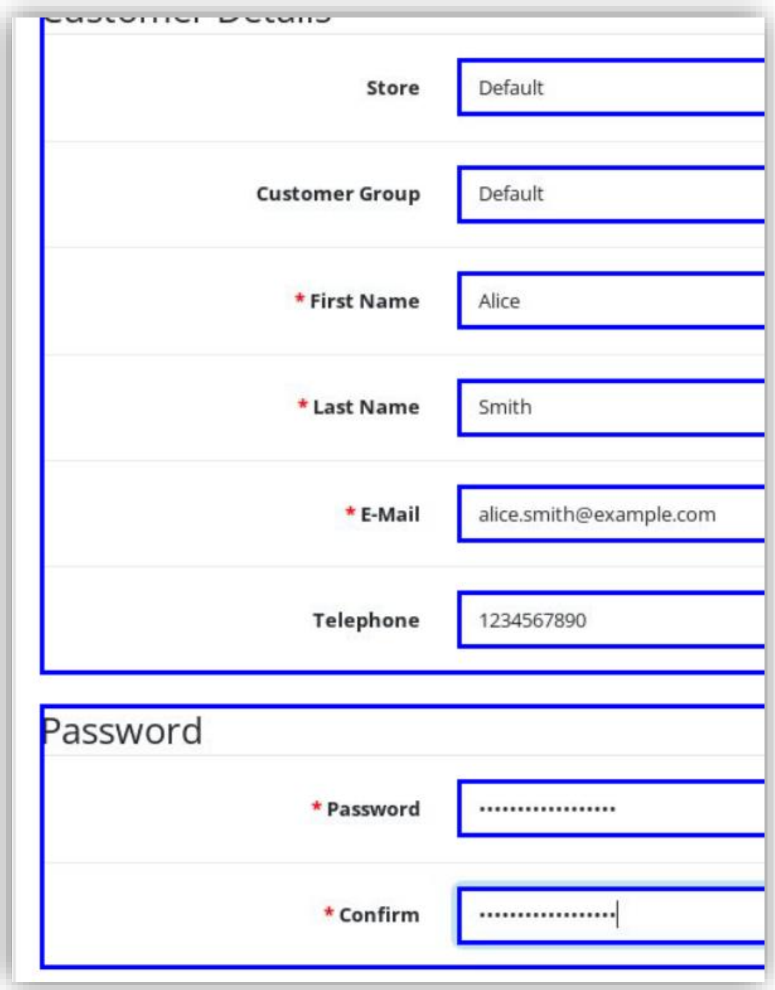

Store	Default
Customer Group	Default
* First Name	Alice
* Last Name	Smith
* E-Mail	alice.smith@example.com
Telephone	1234567890

Password

* Password	••••••••••••••••••
* Confirm	••••••••••••••••••

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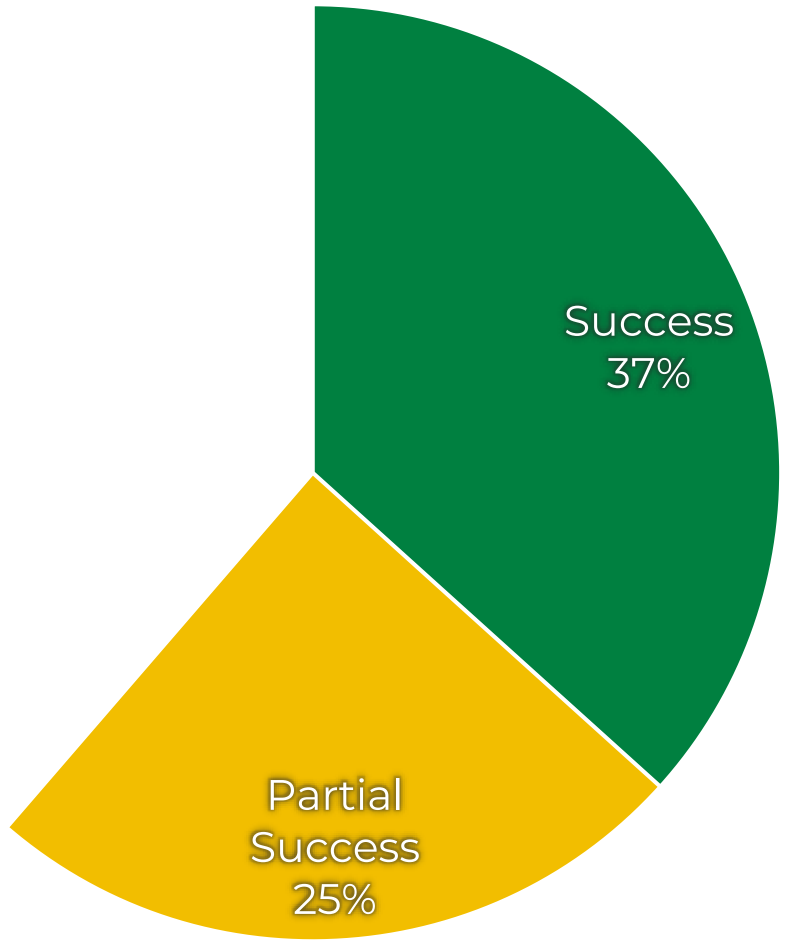

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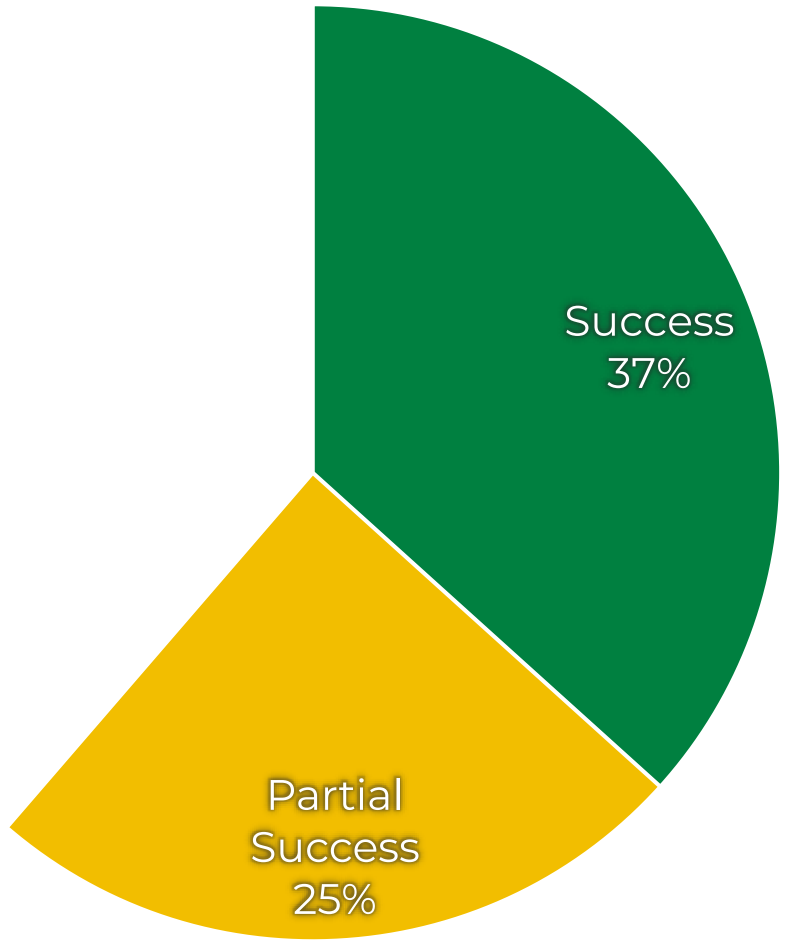

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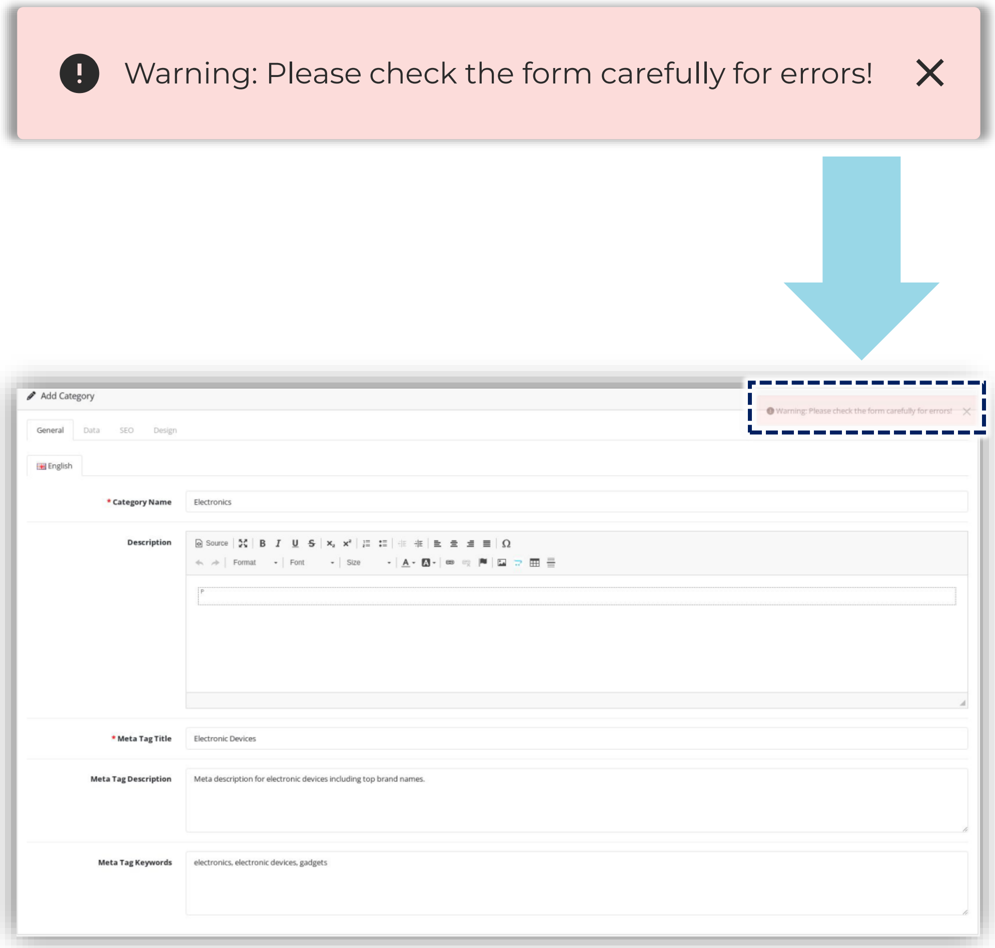


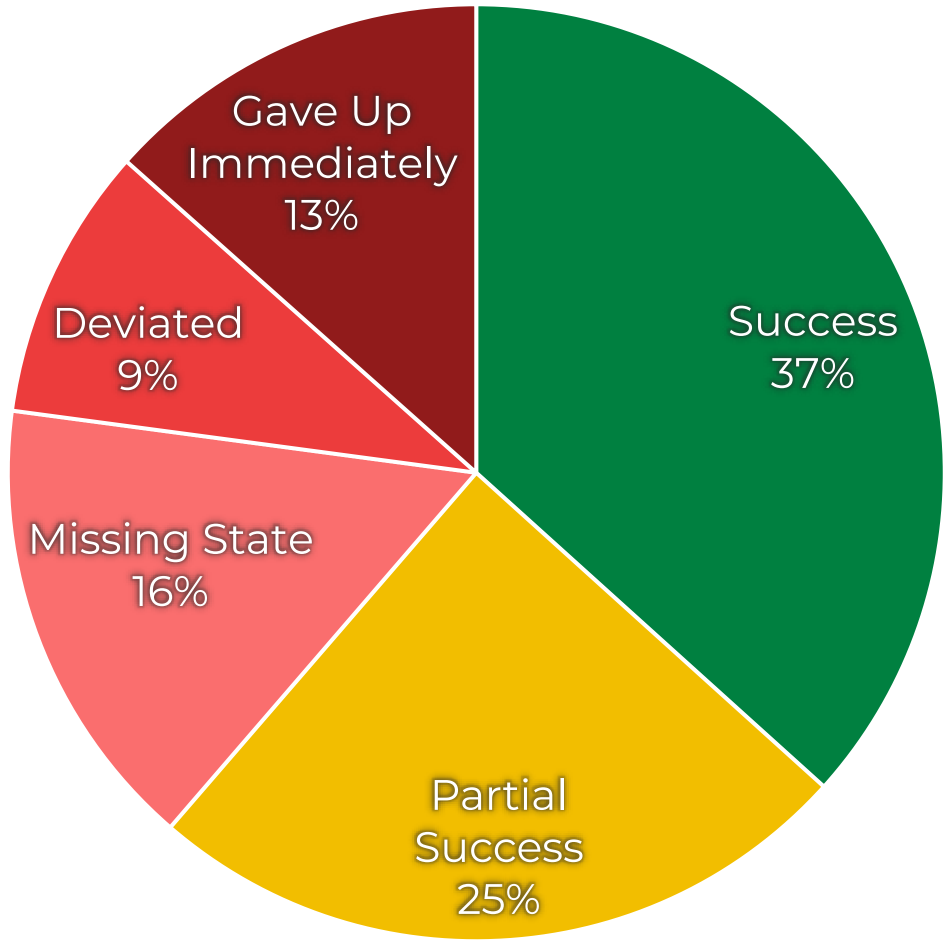
Warning: Please check the form carefully for errors!

Add Category

* Category Name	Electronics
Description	
* Meta Tag Title	Electronic Devices
Meta Tag Description	Meta description for electronic devices including top brand names.
Meta Tag Keywords	electronics, electronic devices, gadgets

Warning: Please check the form carefully for errors!

Evaluation Results: Task Execution



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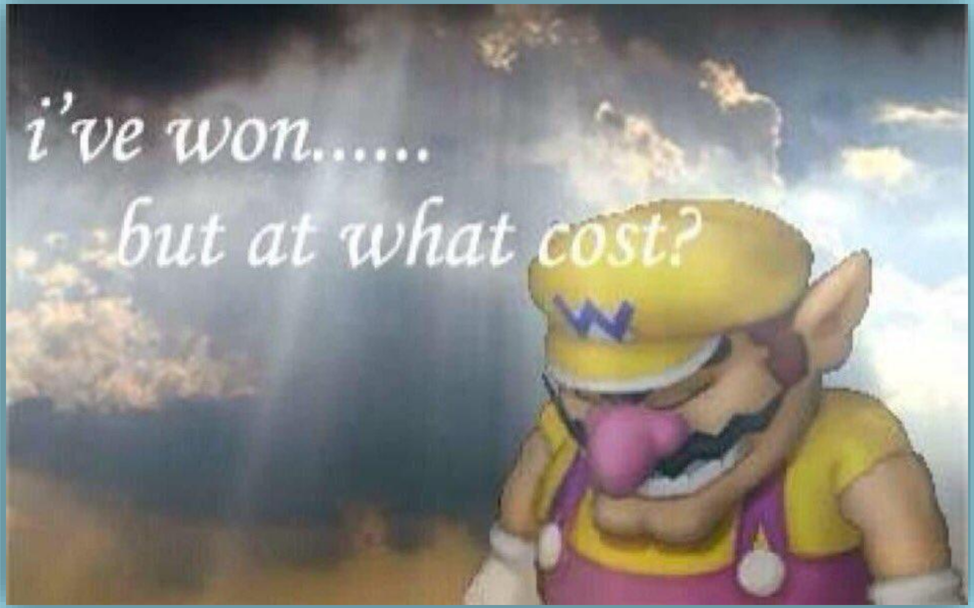
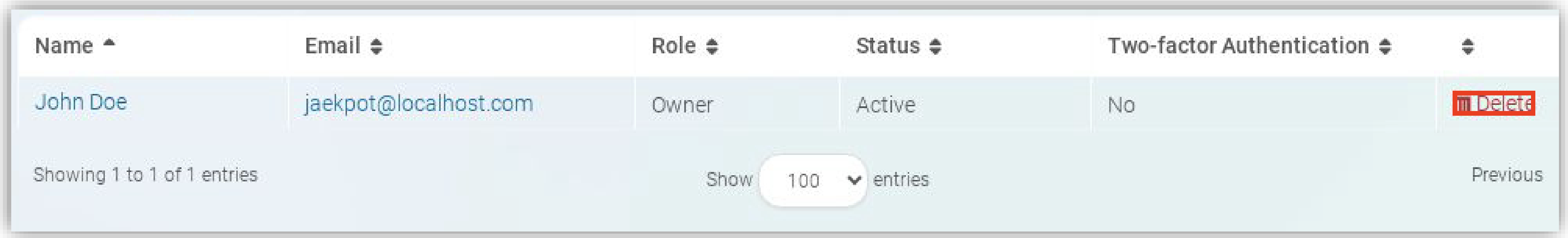
Suffering from Success



Suffering from Success

Task: “Delete a user from the ‘User Management’ section.”



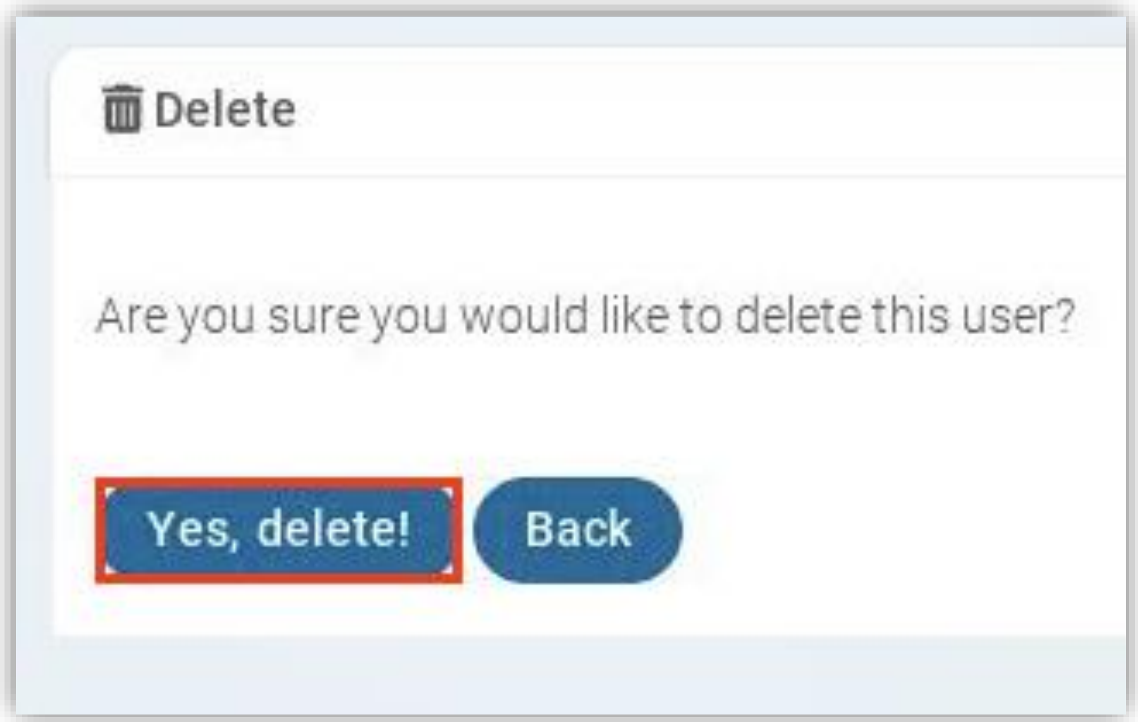
Name	Email	Role	Status	Two-factor Authentication	
John Doe	jaekpot@localhost.com	Owner	Active	No	Delete

Showing 1 to 1 of 1 entries

Show 100 entries

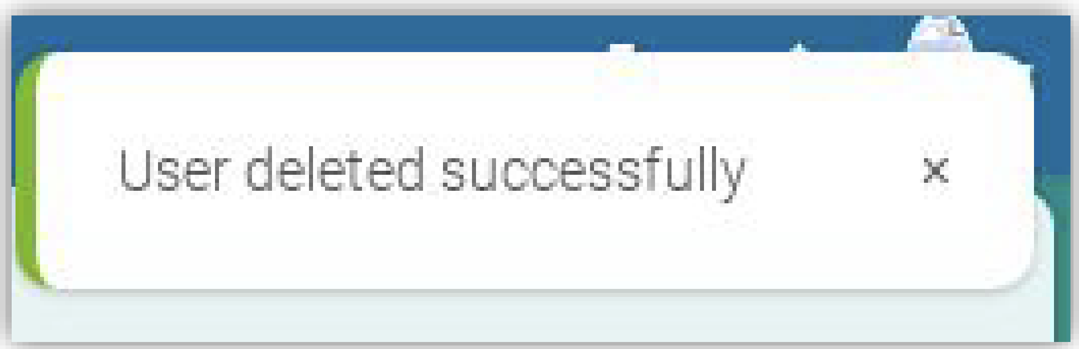
Previous

Suffering from Success

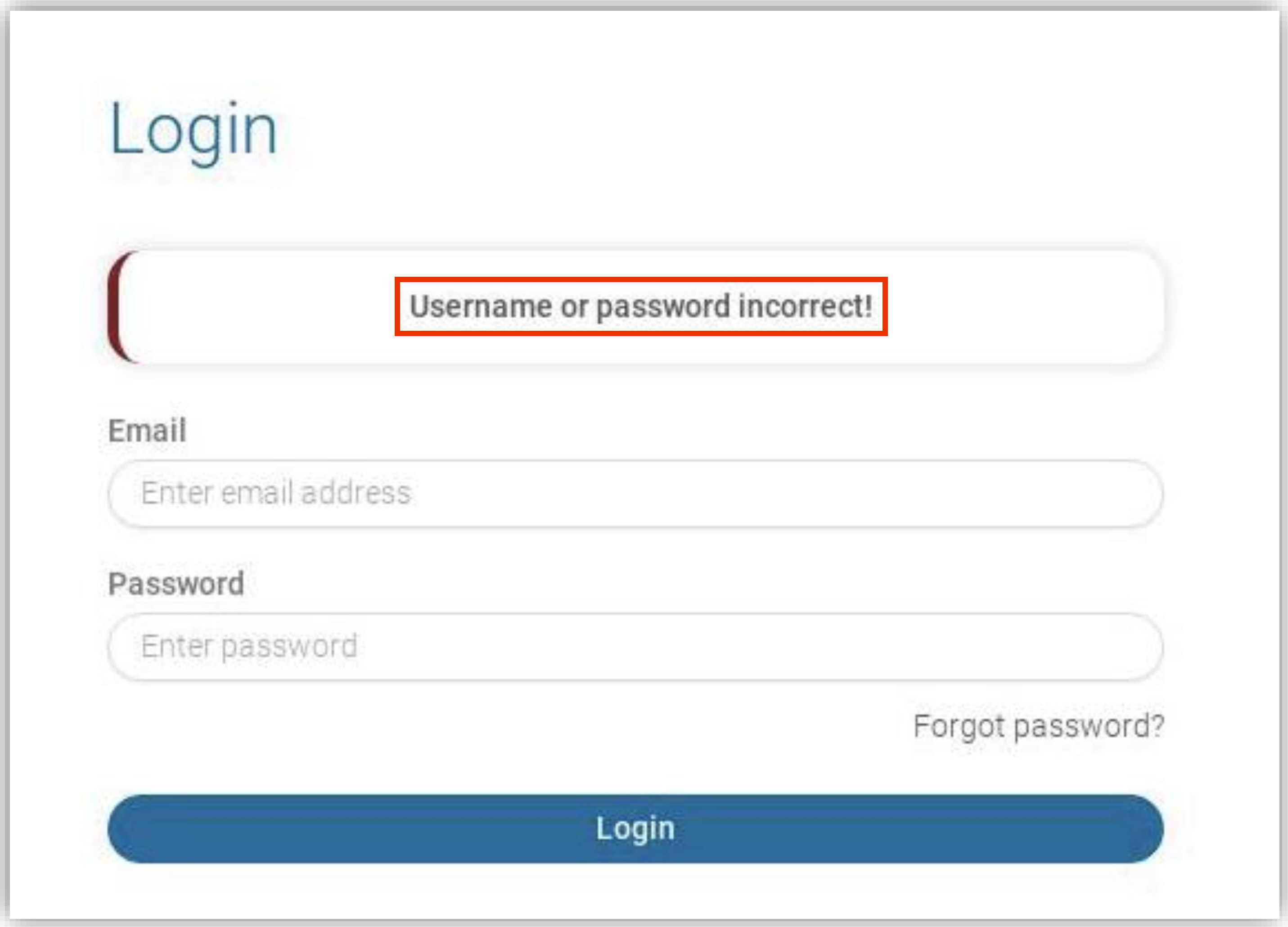


Are you sure you would like to delete this user?

Suffering from Success


User deleted successfully

Suffering from Success


Login

Username or password incorrect!

Email

Enter email address

Password

Enter password

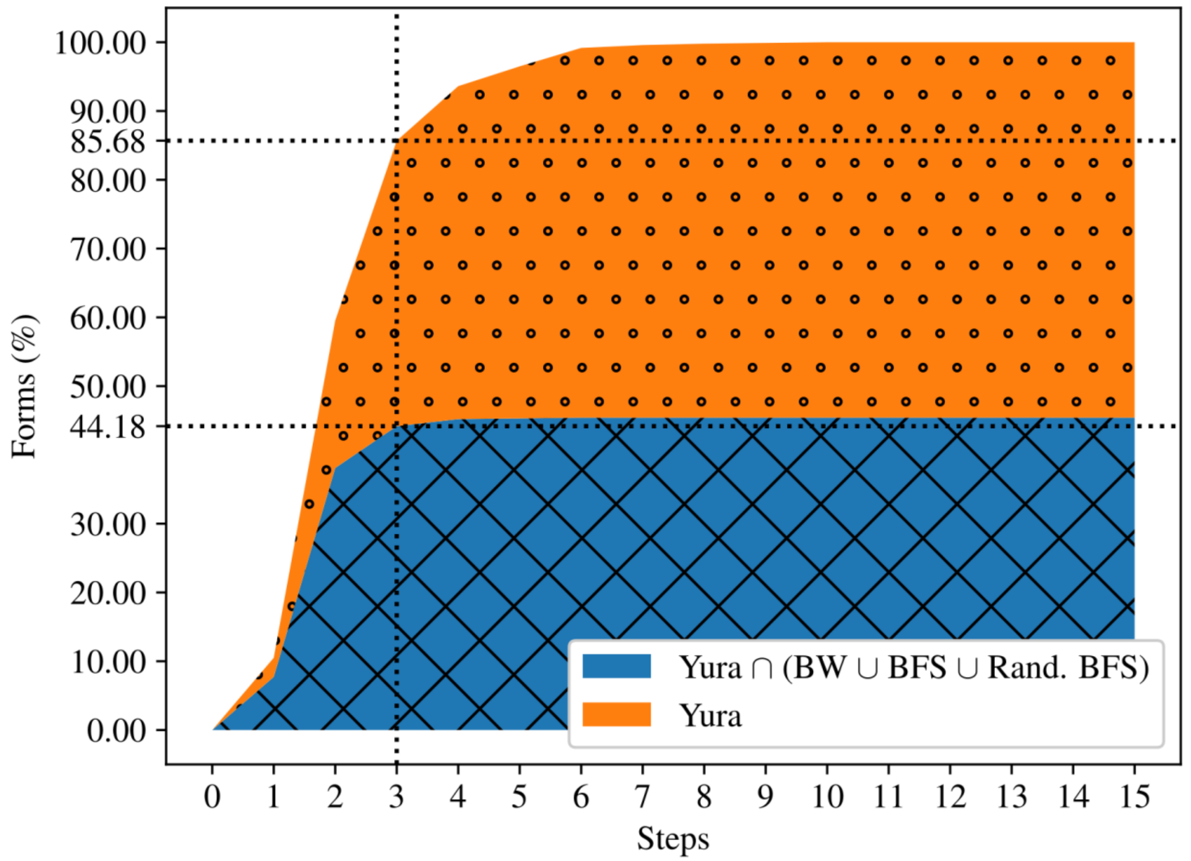
Forgot password?

Login

Directed by
ROBERT B. WEIDE

Characterization of the New Attack Surface

- Is the new attack surface found by YuraScanner "deeper"?



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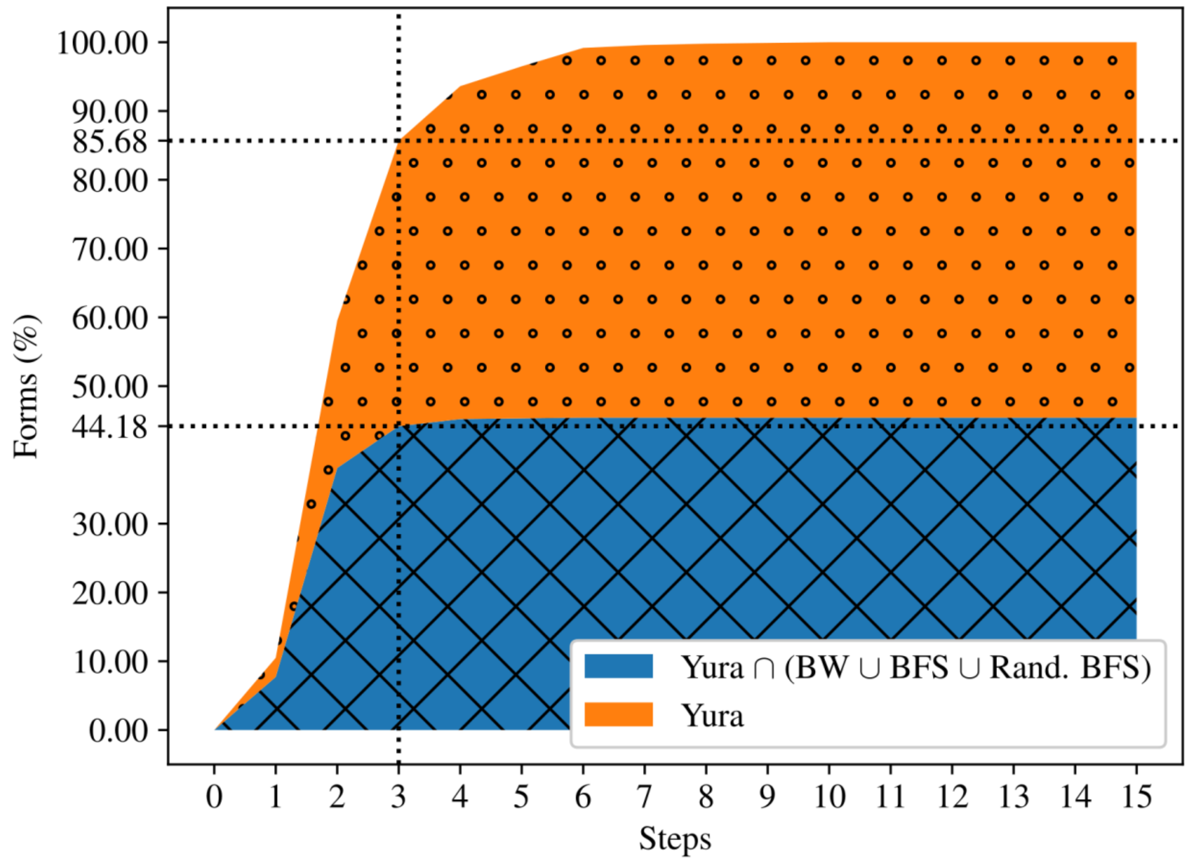

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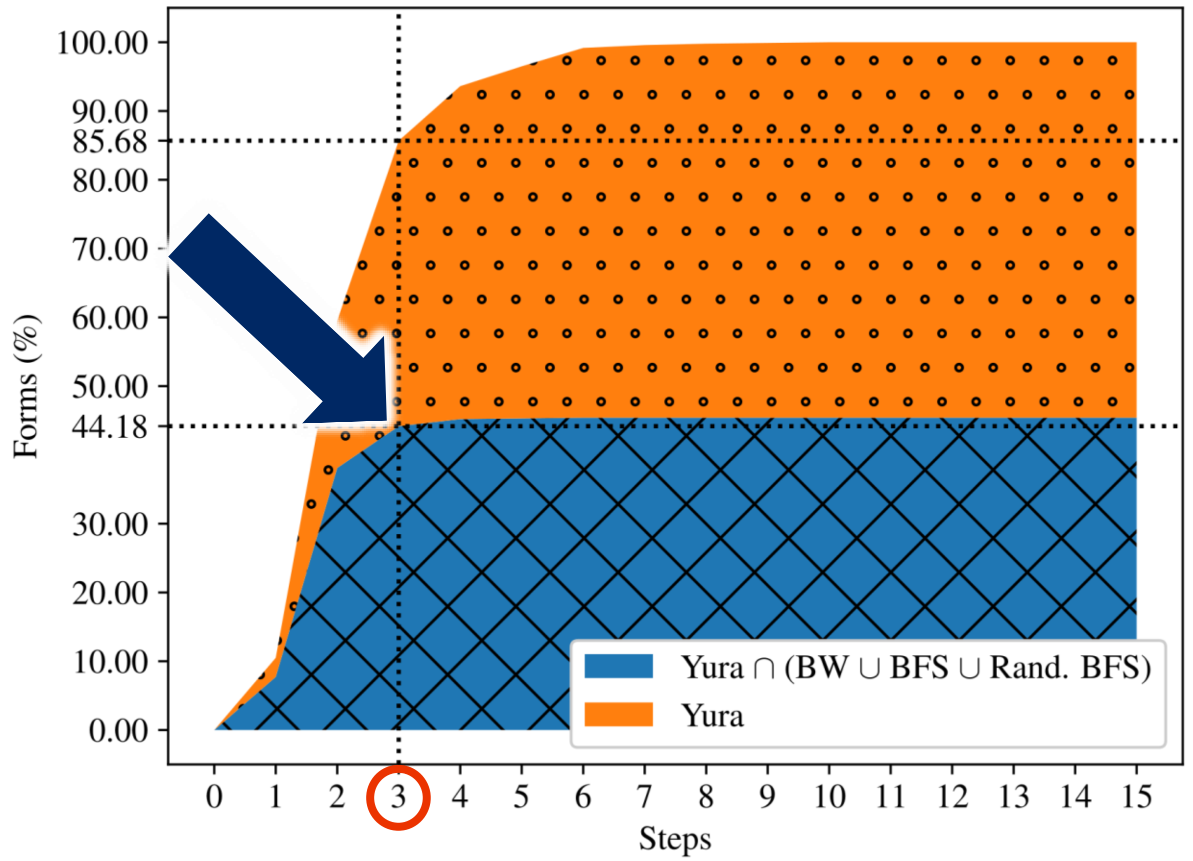

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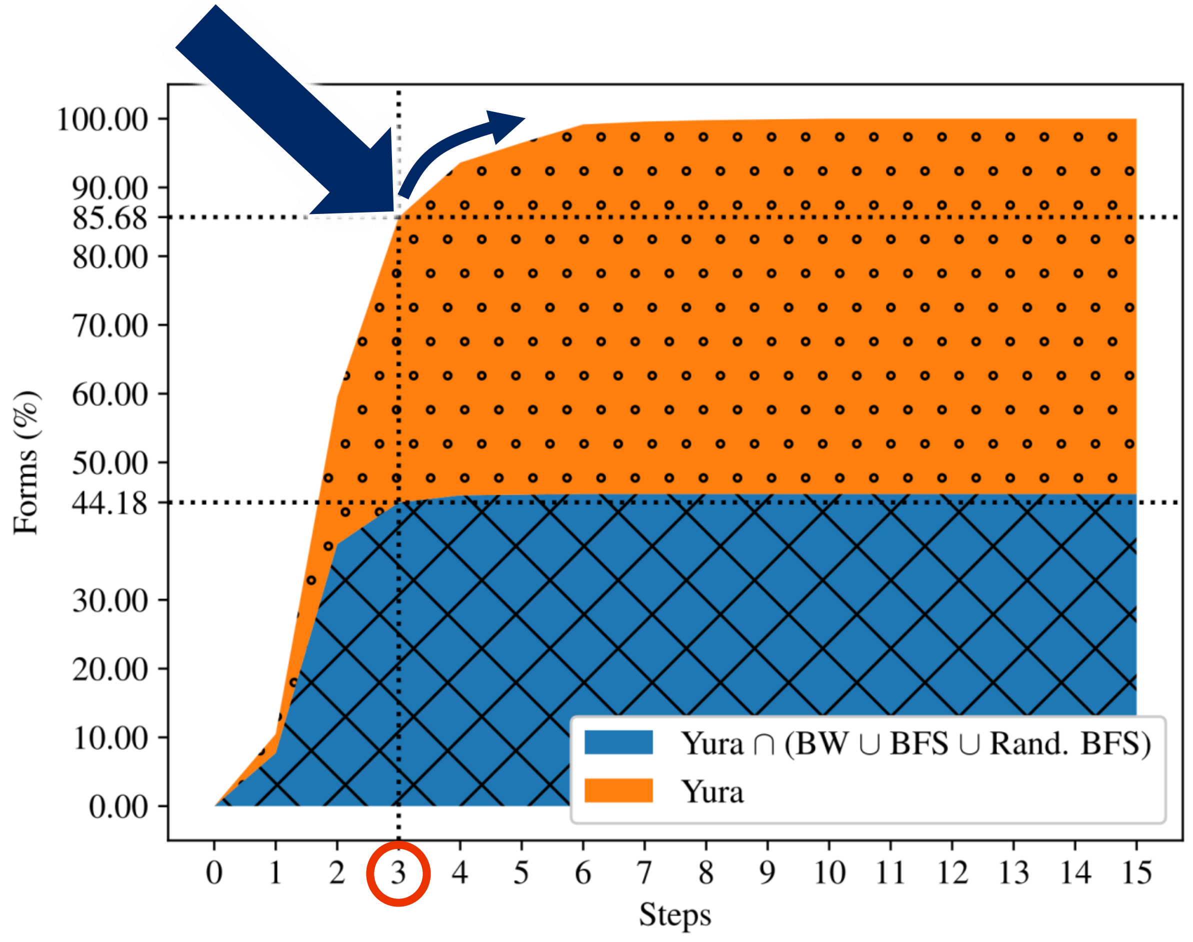

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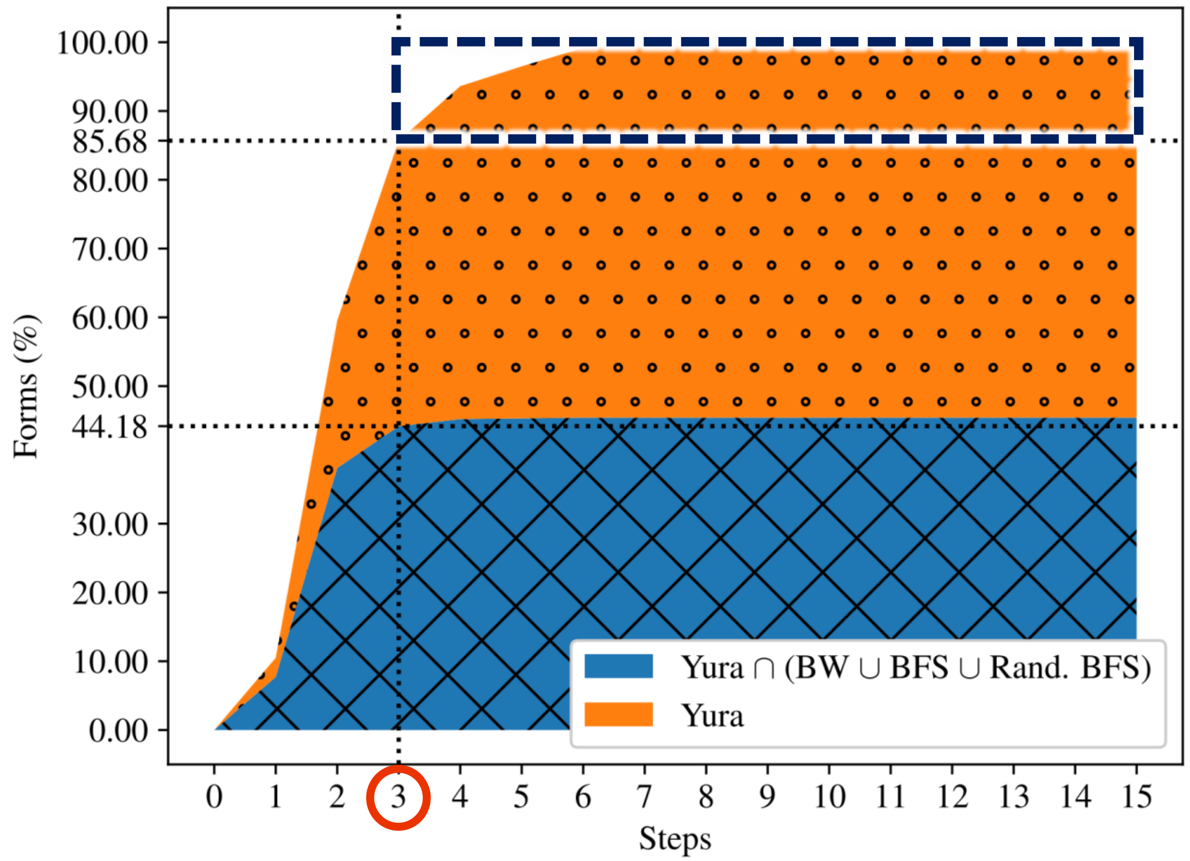
- Percentage of forms collected the deeper we go into the web app
- 44% of forms also discovered by at least one other tool
- Remaining 14.3% of forms with depth > 3
- Out of reach for existing tools!



Vulnerability Detection

App	Total	Unique	YuraScanner		Black Widow	
			Stored XSS	*Reflected XSS*	*Stored XSS*	*Reflected XSS*
Redacted	**12**	**11**	**4**	**7**	-	**1**
Moodle	**2**	**1**	**1**	-	**1**	-
Leantime	**1**	**1**	-	-	**1**	-

- 13 unique zero-day vulnerabilities discovered
- 12 of them found by YuraScanner

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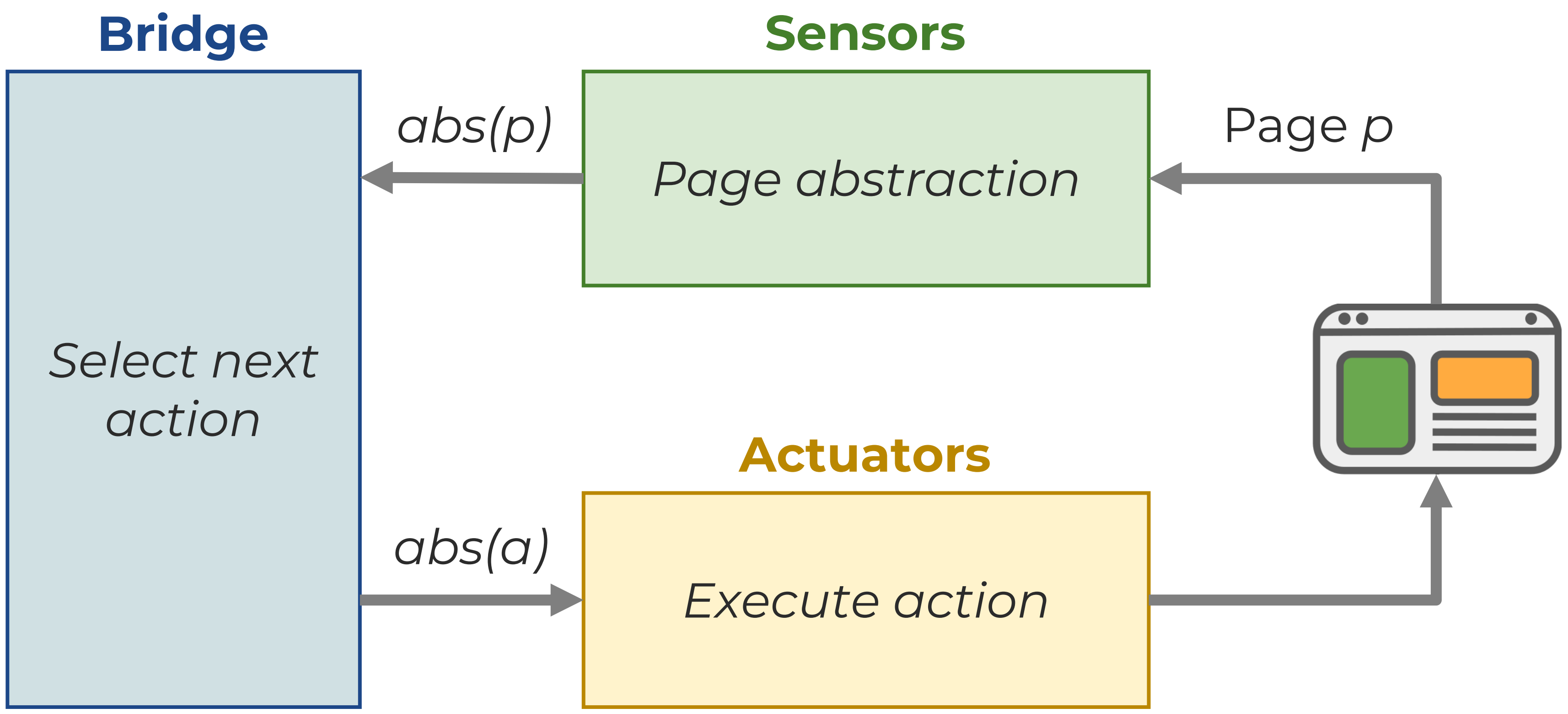
- 13 unique zero-day vulnerabilities discovered
- 12 of them found by YuraScanner
- Located between four and two clicks away from the main page

Summary

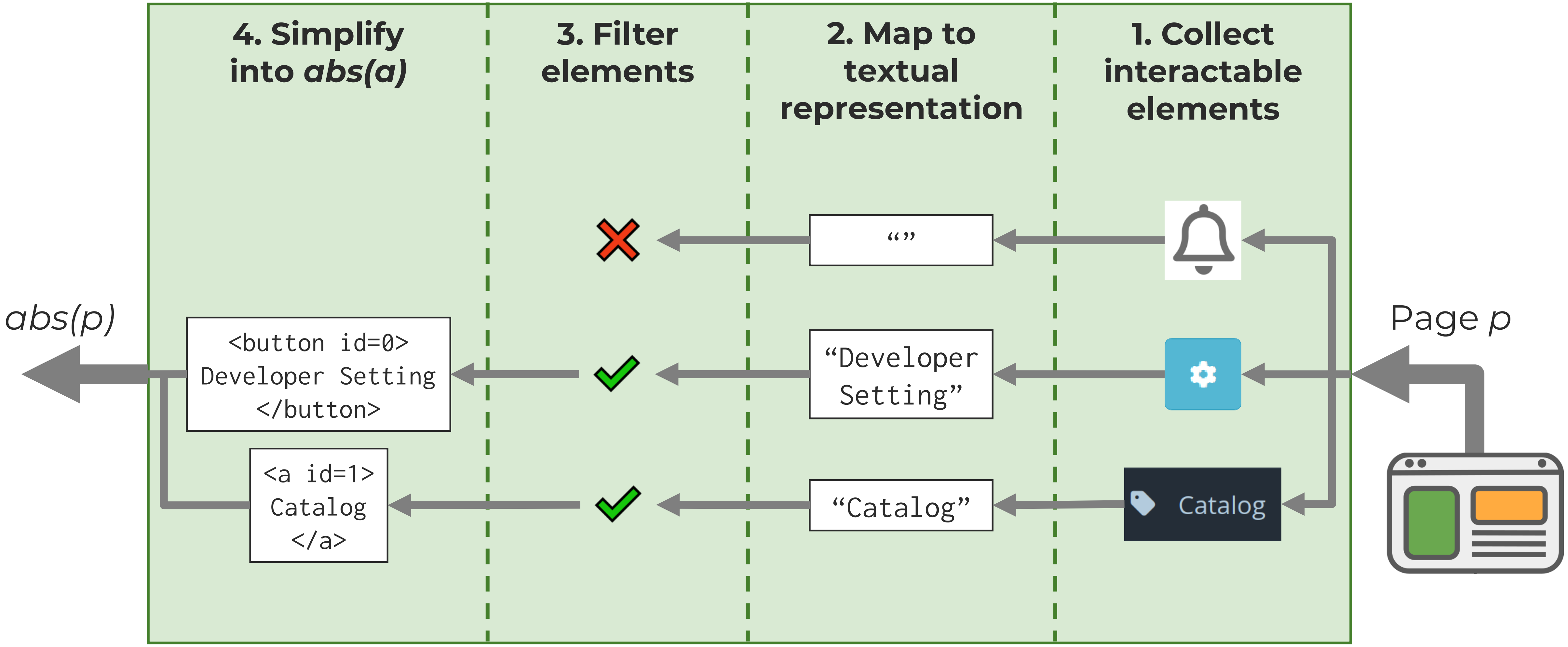
- We implemented **YuraScanner**, a task-driven web application scanner
- Fully automated approach
- YuraScanner executed 61.3% of the valid tasks completely or partially
- The unique attack surface discovered by YuraScanner is deeper compared to traditional scanners
- Task-driven crawling effectively complements traditional scanning techniques

Artifact Evaluated
NDSS SYMPOSIUM
Functional
Reproduced

Task-driven Crawler Component

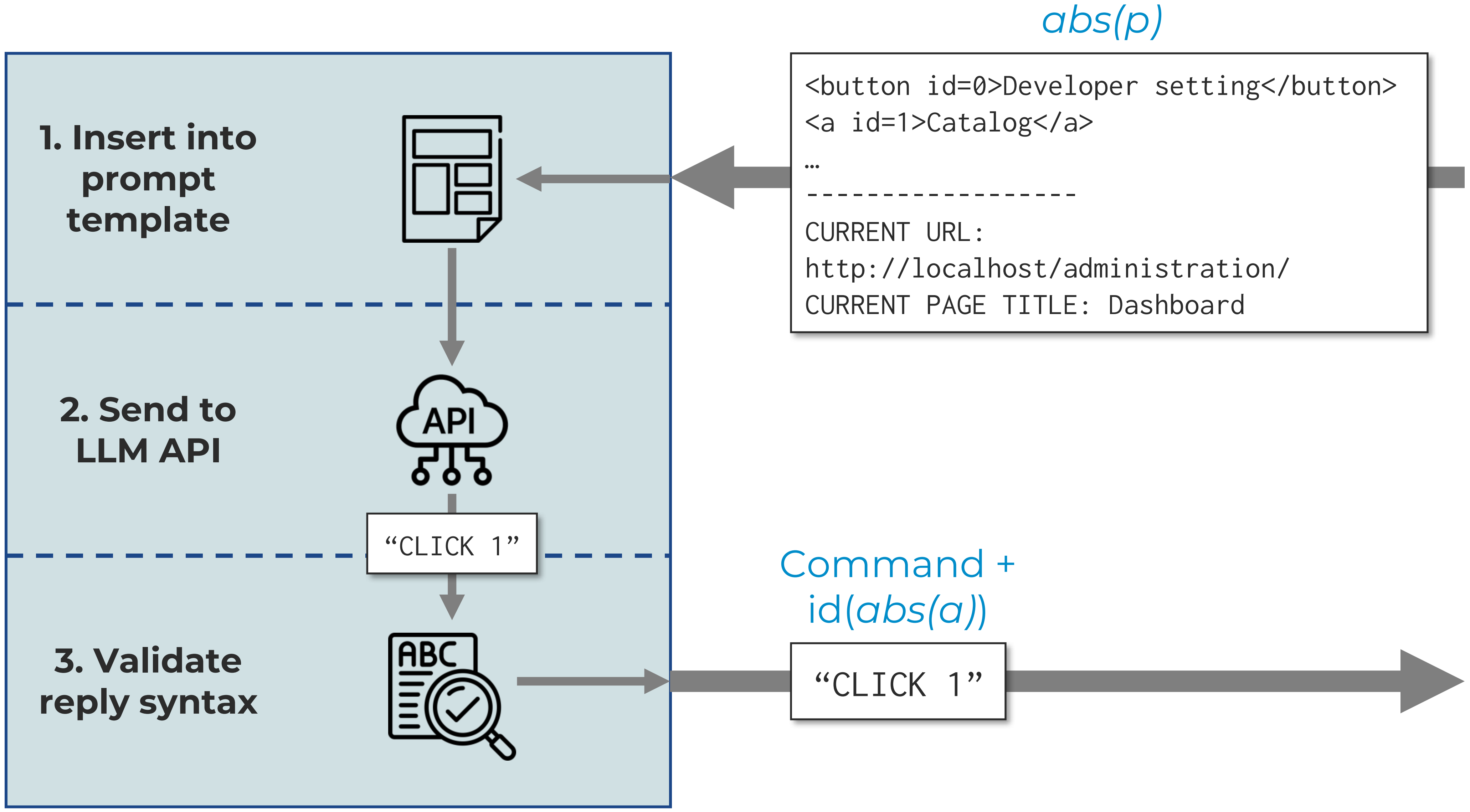


Sensors



4. Simplify into *abs(a)*
3. Filter elements
2. Map to textual representation
1. Collect interactable elements
abs(p)
Page *p*
“”
“Developer Setting”
“Catalog”
Catalog
<button id=0> Developer Setting </button>
<a id=1> Catalog </a>

Bridge



```
<button id=0>Developer setting</button>
<a id=1>Catalog</a>
…
------------------
CURRENT URL:
http://localhost/administration/
CURRENT PAGE TITLE: Dashboard
```

Bridge: LLM Prompt

Preamble with instructions

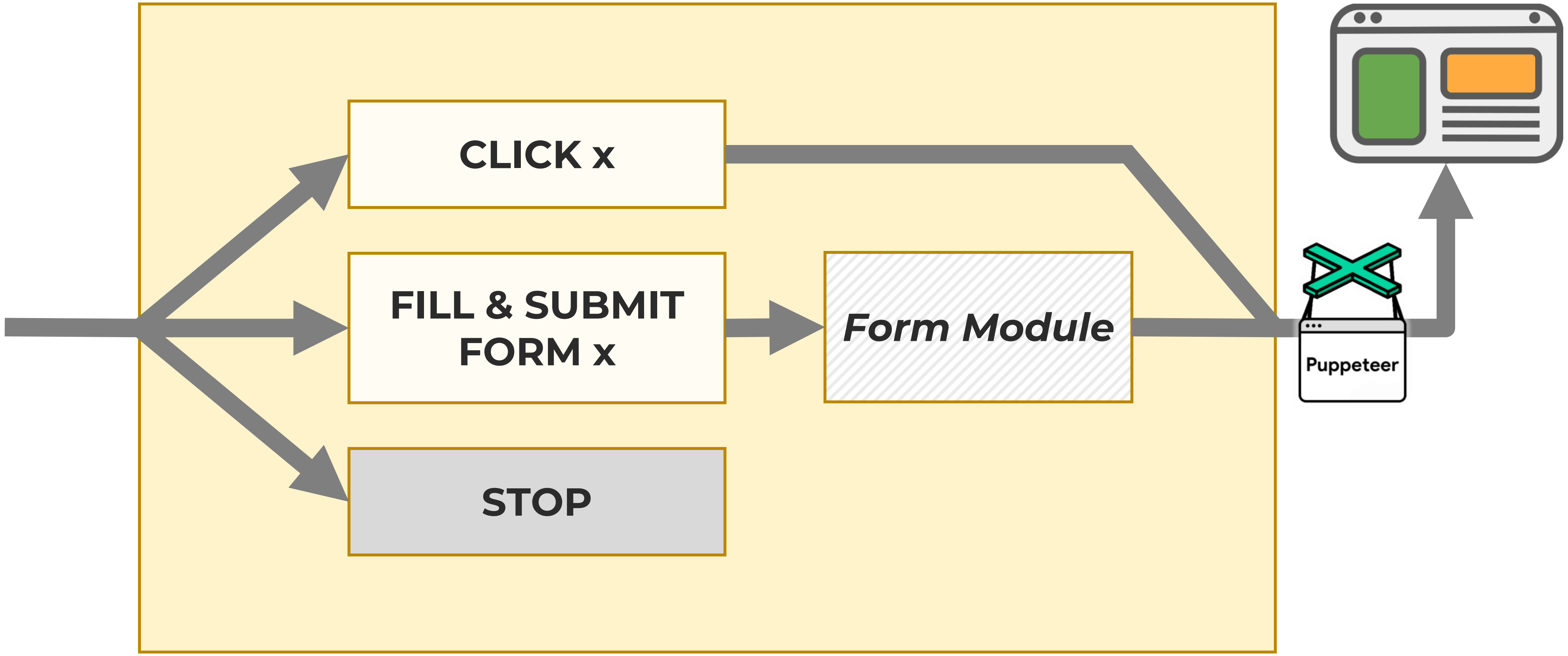
- Persona assignment to increase focus:
  "*You are Yura, an agent controlling a web browser*"
- Explanation of abstract page
- Command types

Example of input and expected output
("One-shot")

Current input

- Current task
- Current abstract page (i.e., *abs(p)*)
- History of previous actions

Actuators


CLICK x
FILL & SUBMIT FORM x
STOP
Form Module
Puppeteer