

# expo IQA 25

MADRID  
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21st & 22nd  
2025



[expoqqa.eu](http://expoqqa.eu)

# Orchestrating LLM Pipelines with Metamorphic Testing for QA Automation



**Víctor Trujillo**

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QA Practice Lead at Capitole, has over 8 years experience as QA Engineer, has multiple backgrounds in different industries, from QA analyst in Finance to QA solution architect in Retail sector. He has worked with some of the most popular tools in QA like K6 for Performance, Cypress, Appium or Newman for Automation and other tools like Sonar, GH Actions or Allure for Continuous Integration and Reporting.



**Victor Saenger**

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Victor Saenger currently serves as the R&D AI Lead at Capitole. He has more than 8 years of experience developing and deploying AI pipelines that tackle real world problems. He holds a PhD in Computer Science and has worked in various industries, from medical to water management and from organisational psychology to information extraction.

# QA Context

## Tasks with the highest dedication:

- Requirement analysis
- Design and maintenance of test cases
- Design and maintenance of automated scripts
- Manual test execution
- Defect management and reporting

## How can we leverage GenAI to support this tasks?



Using **ChatGPT** for requirement analysis and test design. Improving efficiency on 2 of these tasks.



**Copilot** helps to cover the task of design and maintenance of automated scripts increasing efficiency on a 3<sup>rd</sup> task.

2 solutions helps us improve on 3 of the 5 tasks that consume the most time during testing lifecycle. These enables us to dedicate more time to the remaining tasks.



Look for a new solution that improves the other 2 tasks?

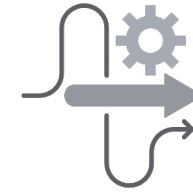
# QA Context

- Manual test execution should still be done. The AI is not as perceptive as a human.
- Defect management still requires manual actions that cannot be decided by AI. Is it worth to automate then?
- ¡We are not disposable yet!



## How about improving the already automated tasks?

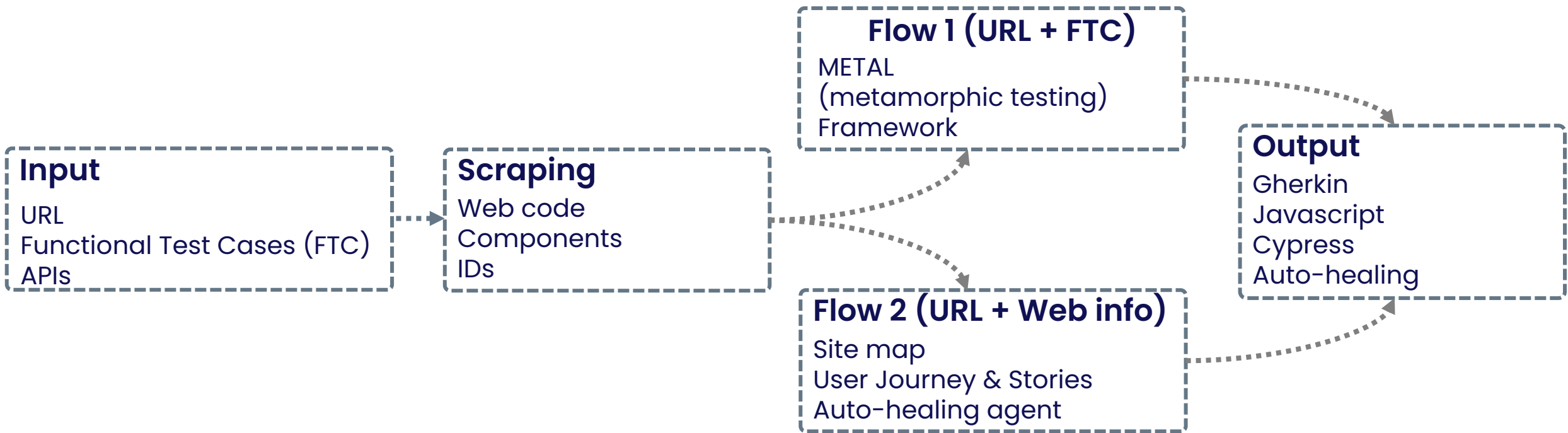
Streamline the tasks from analysis requirement to script automation.

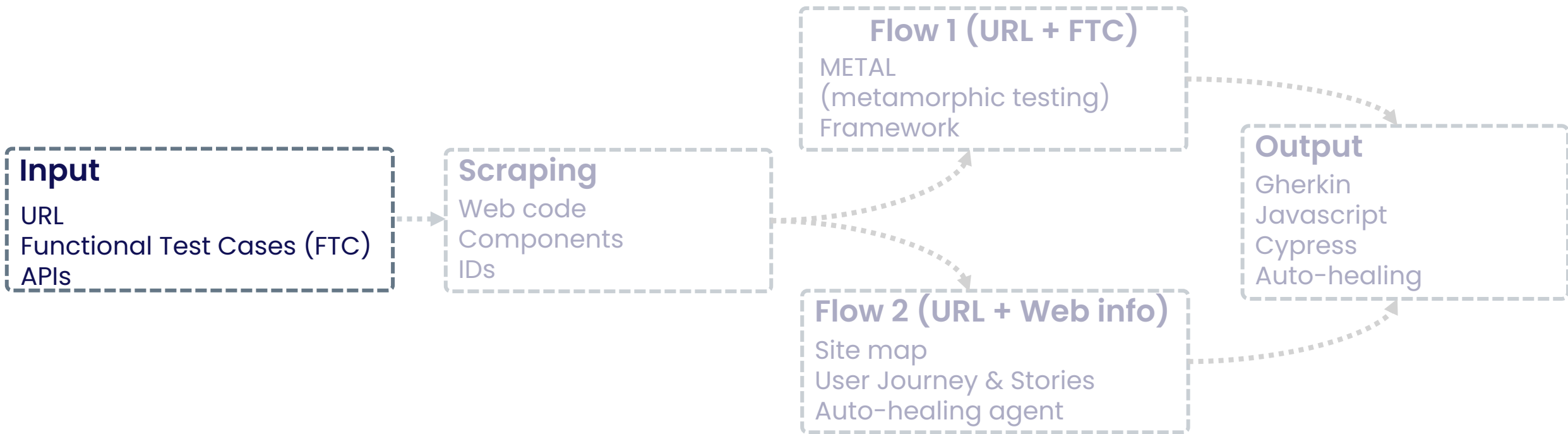


Accelerating these tasks gives the QA even more time to dedicate to the manual ones.

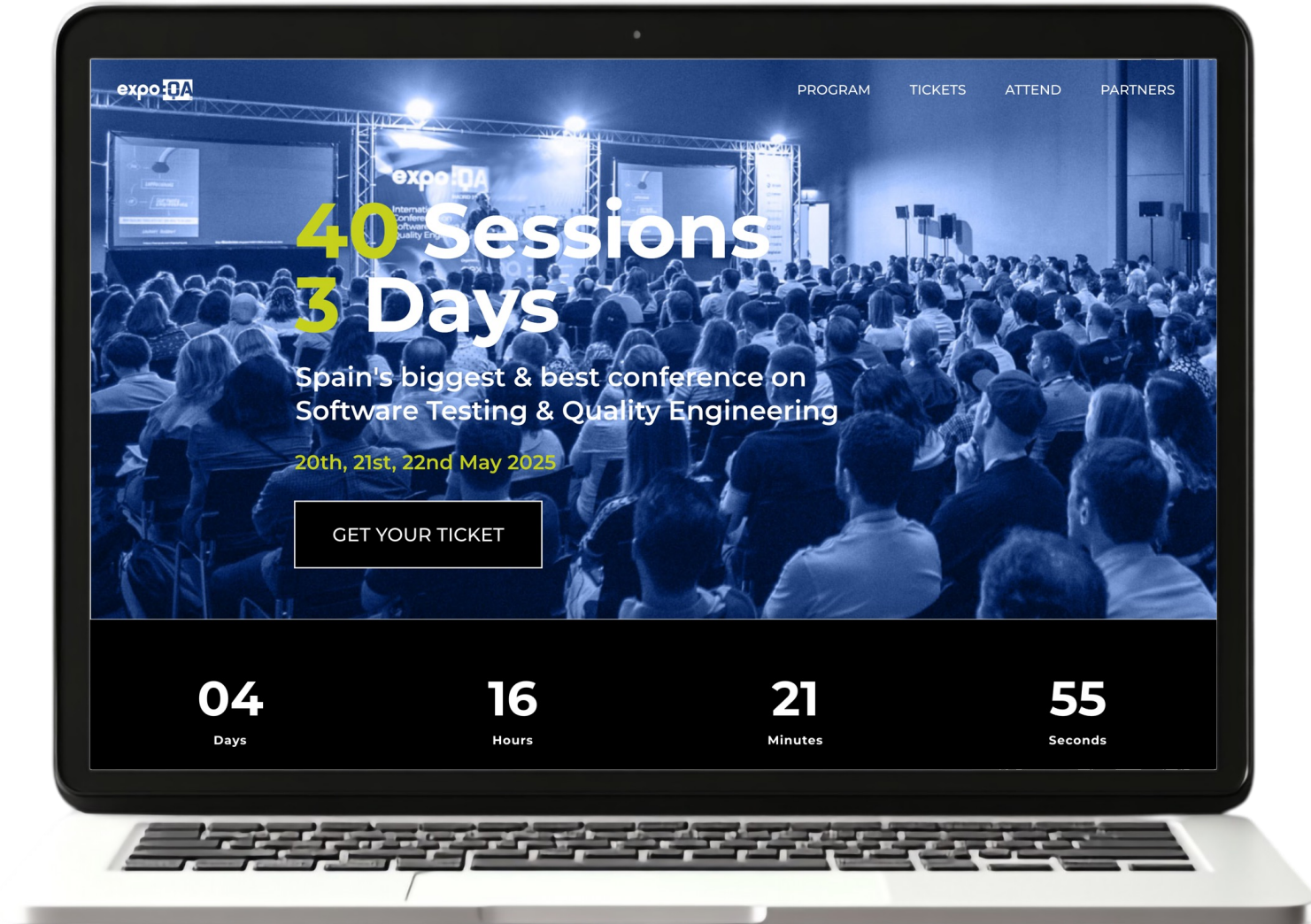


**How does it look?**

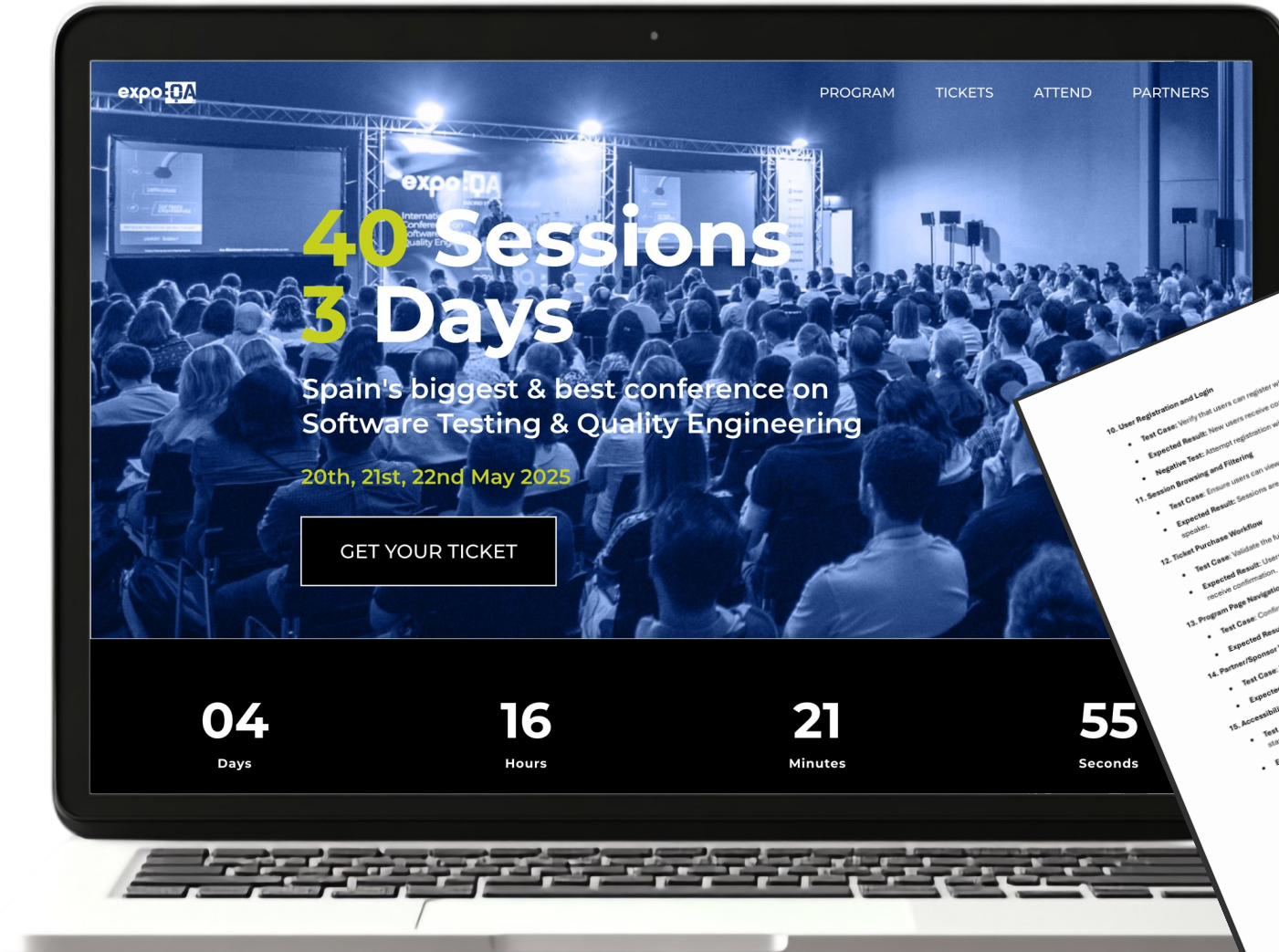




# Input

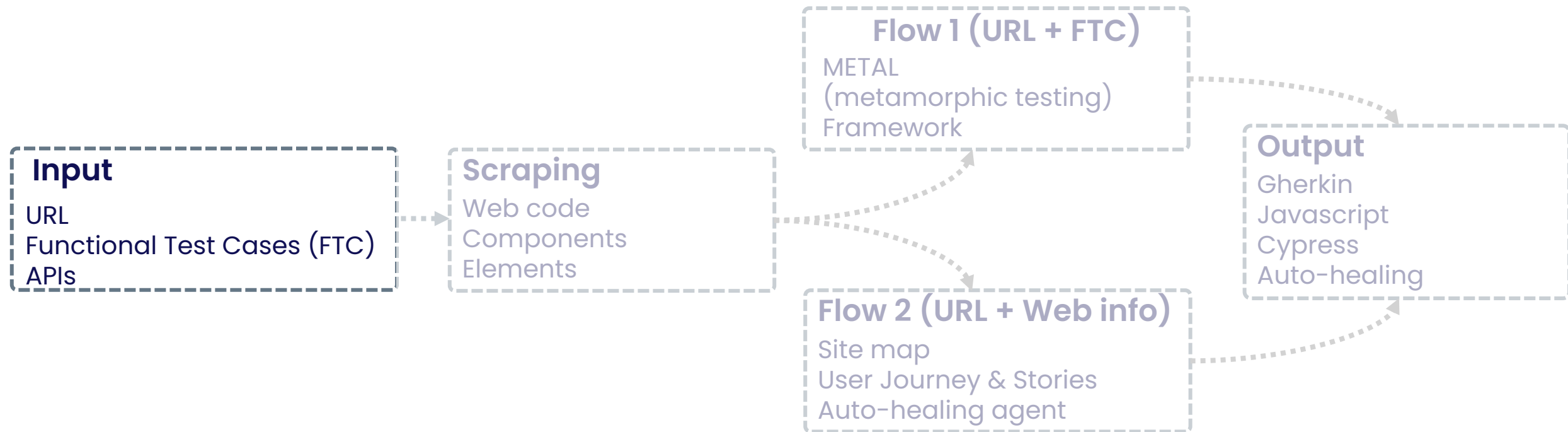


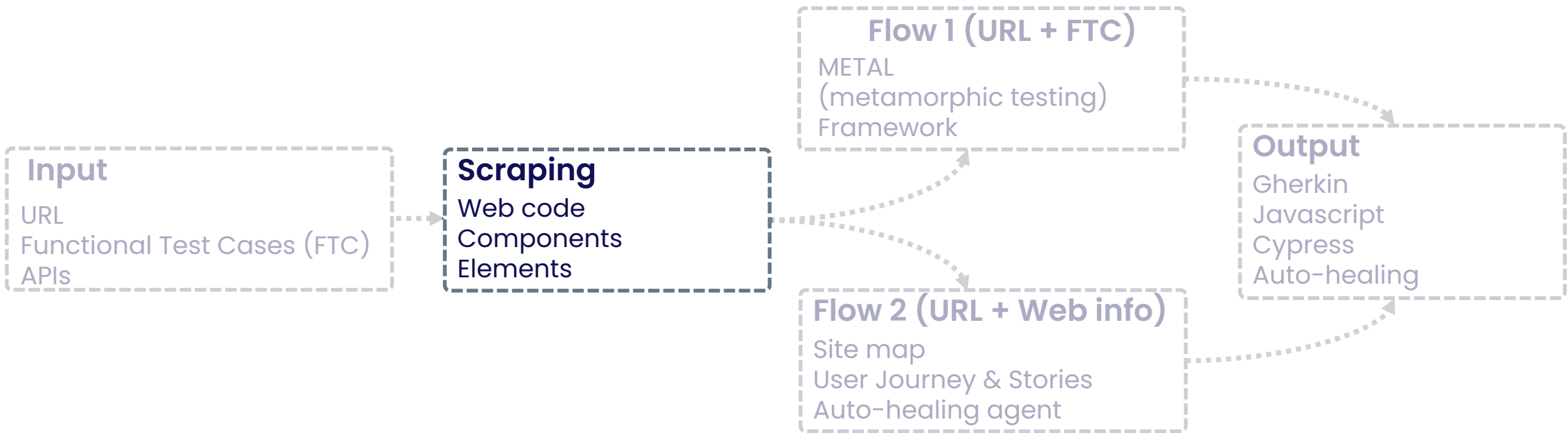
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# Web Analysis Engine (WAE)

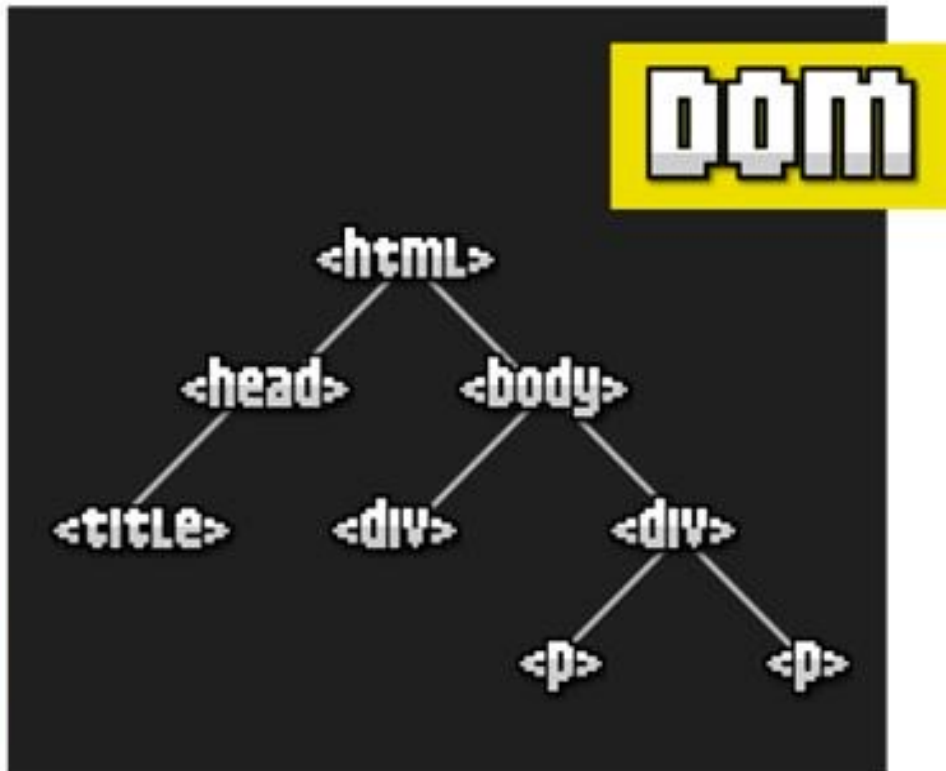
Information extraction through LLMs:

- Content
- DOM & Navigations
- Interactive elements

This analysis is the essential foundation for all subsequent steps, driving functional requirements and Cypress test generation.

# Web Analysis Engine (WAE)

## DOM & Navigations

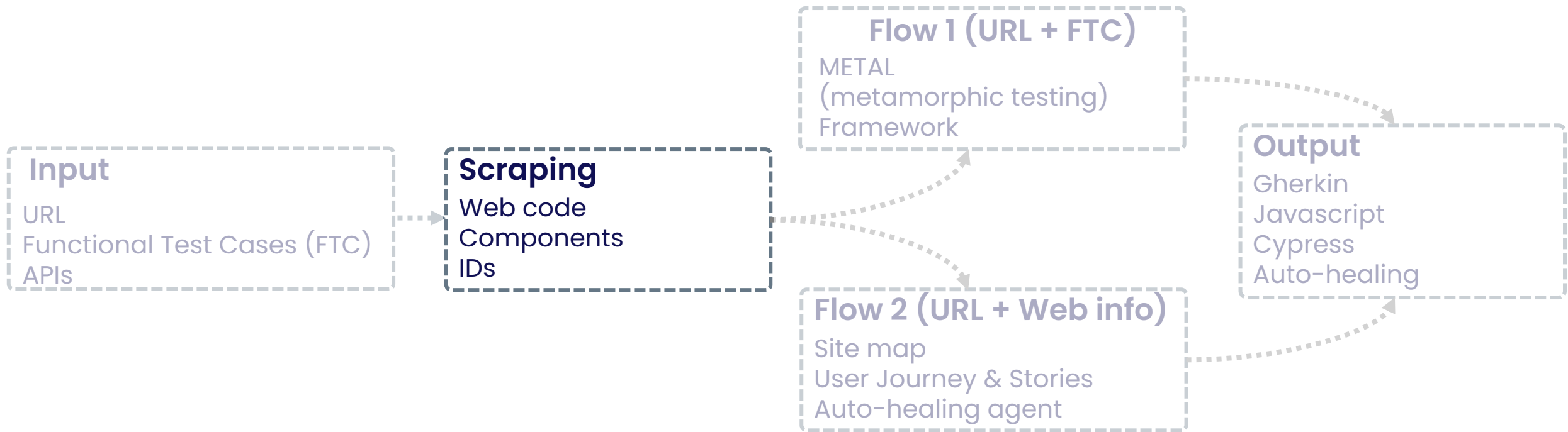


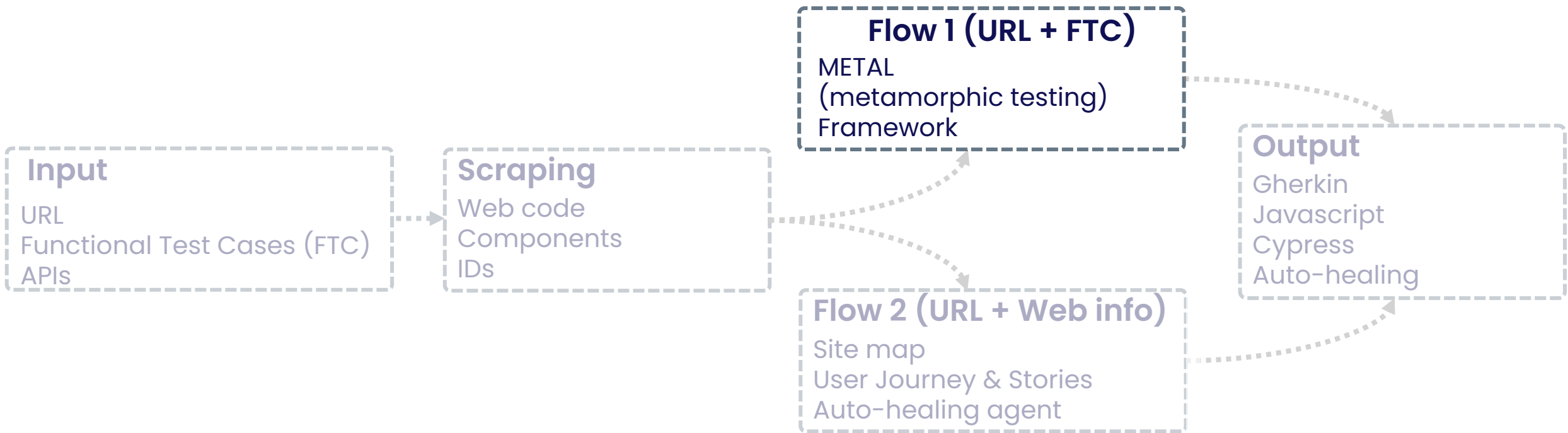
```
1  "pages": [  
2    {  
3      "page_id": "page_001",  
4      "url": "https://capitole-consulting.com/es/",  
5      "title": "Capitole | Expertos en soluciones de innovación tecnológica",  
6      "content_snippet": "Empowering people Unlocking innovation. Transformamos des",  
7      "markdown_file": "markdown_content/page_001.md",  
8      "links": [  
9        "https://capitole-consulting.com/es/politica-de-cookies/",  
10       "https://capitole-consulting.com/es/politica-de-privacidad/",  
11       "https://test.capitole-consulting.com/es/contacto/",  
12       "https://www.linkedin.com/company/capitole-consulting/jobs/",  
13       "https://test.capitole-consulting.com/es/soluciones#solutions",  
14       "https://test.capitole-consulting.com/es/industrias/",  
15       "https://test.capitole-consulting.com/es/sobre-nosotros/",  
16       "https://view.genially.com/67234958edb4c79c9de2094e",  
17       "https://view.genially.com/6745fc7b969c9b50488c6300",  
18       "https://view.genially.com/678795af95e29d0cbfbb83a4",  
19       "https://test.capitole-consulting.com/es/vacantes/",  
20       "https://www.linkedin.com/company/capitole-consulting/",  
21       "https://x.com/capitolecons",  
22       "https://www.youtube.com/@capitoleconsulting",  
23       "https://g.co/kgs/oDrkpYV"  
24     ]  
25   }  
]
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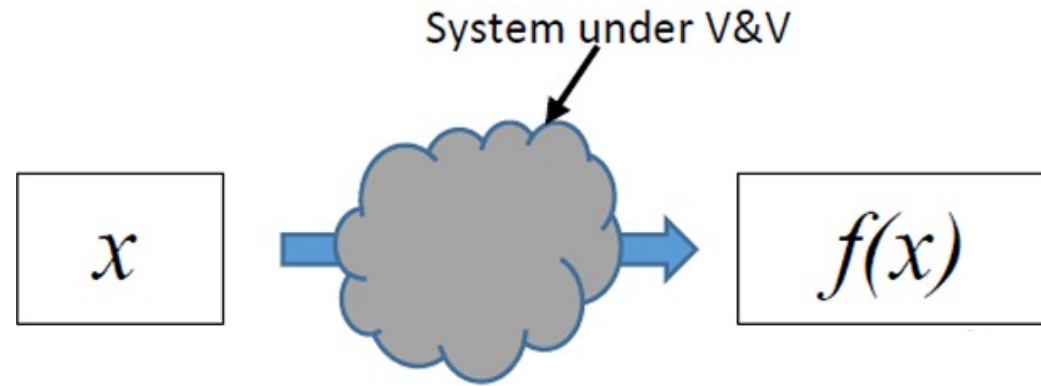
Interactive elements extraction

```
1 {
2   "html_tag": "input",
3   "description": "Contact Form (Vacantes): Privacy policy checkbox",
4   "attributes": {
5     "id": "form-field-field_bfda48d",
6     "name": "form_fields[field_bfda48d]",
7     "class": "elementor-field elementor-size-xs elementor-acceptance-field",
8     "href": null,
9     "type": "checkbox",
10    "placeholder": null,
11    "text": "He leído y acepto la política de privacidad",
12    "method": null,
13    "action": null
14  },
15  "action_type": "data_entry",
16  "action_target": null
17 },
{
  "html_tag": "button",
  "description": "Contact Form (Vacantes): Enviar button",
  "attributes": {
    "id": null,
    "name": null,
    "class": "elementor-button elementor-size-md elementor-animation-shrink",
    "href": null,
    "type": "submit",
    "placeholder": null,
    "text": "Enviar",
    "method": null,
    "action": null
  },
  "action_type": "form_submission",
  "action_target": null
},
```



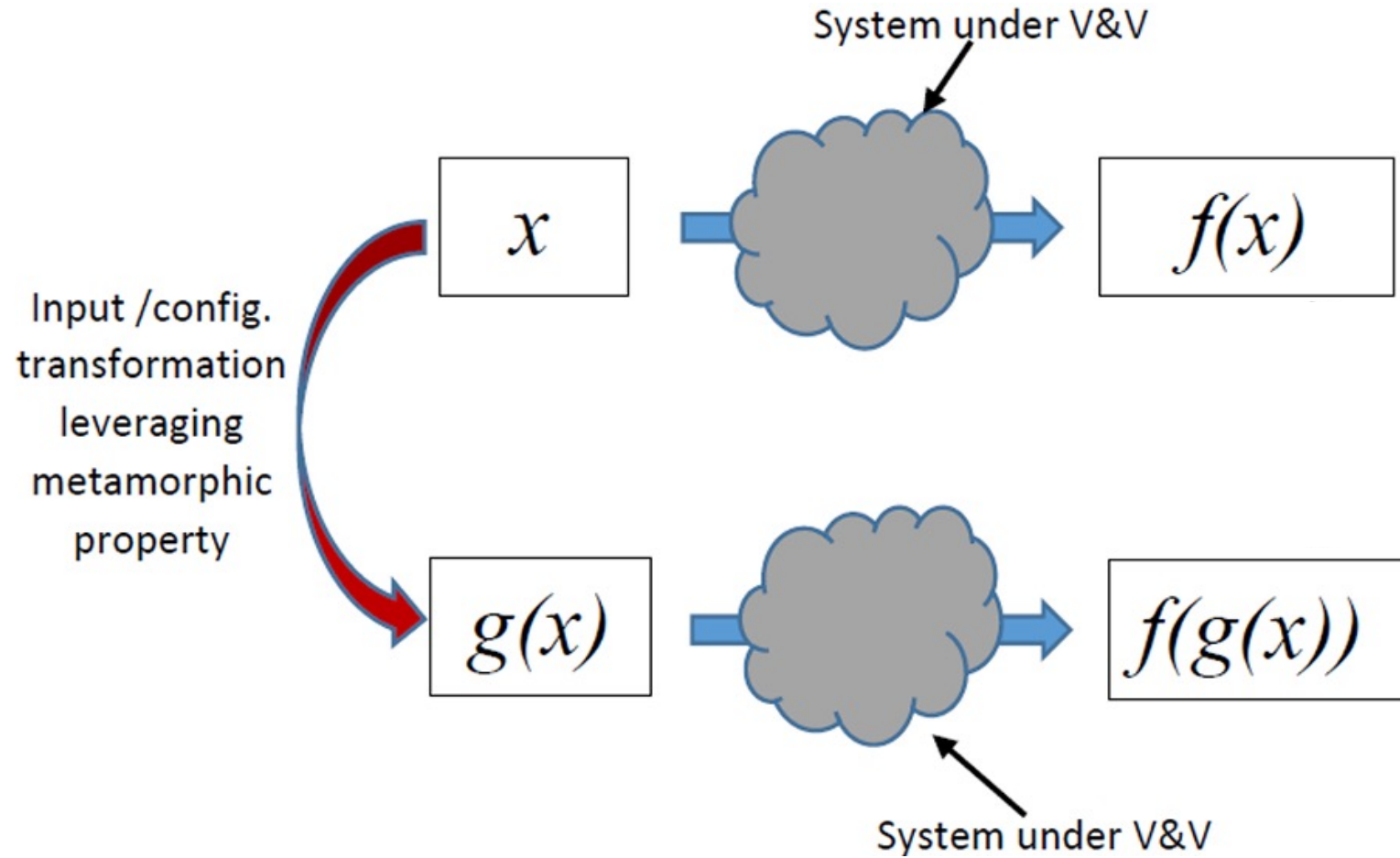


# Metamorphic Testing



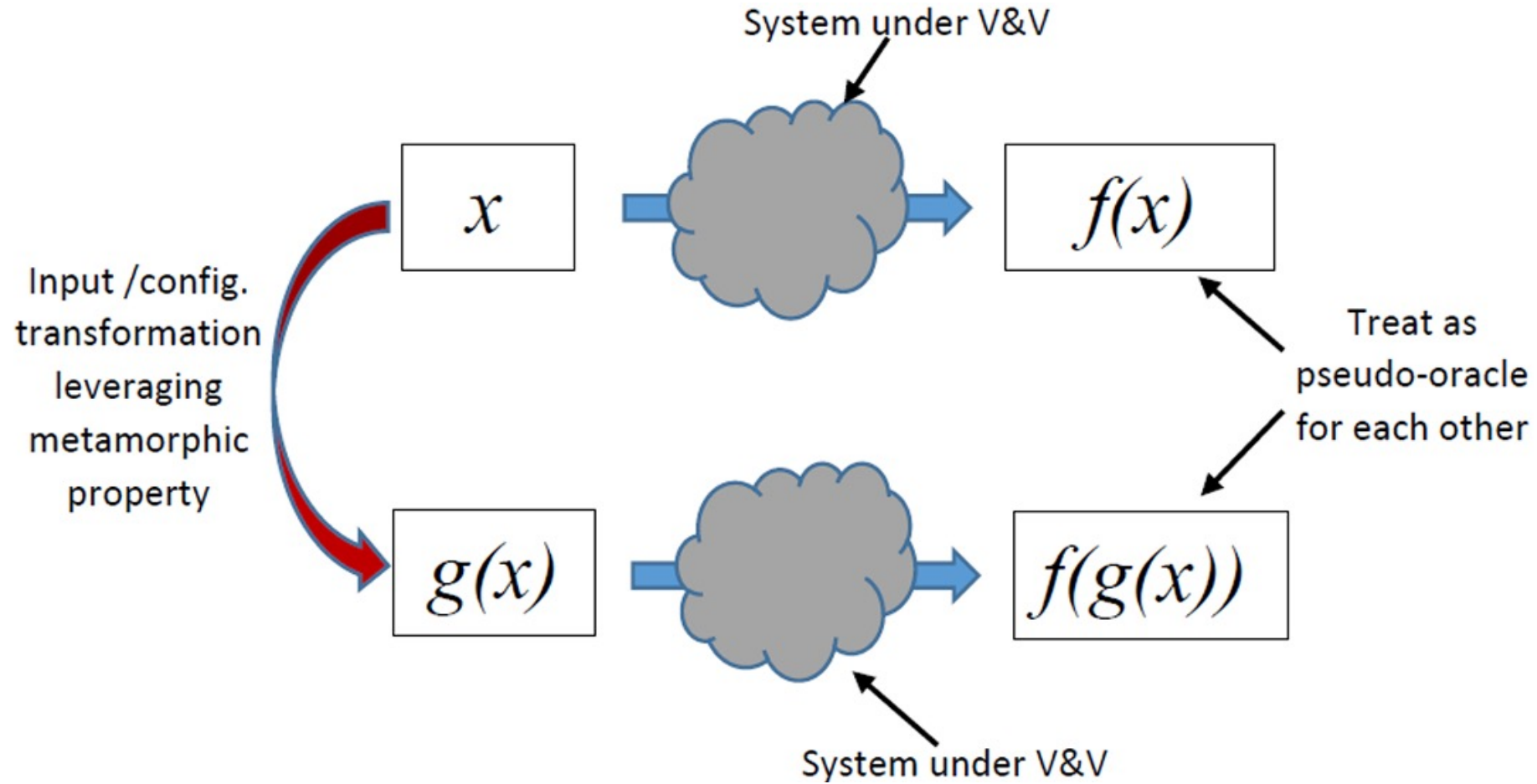
Raunak & Olsen (2015). Simulation Validation Using Metamorphic Testing

# Metamorphic Testing



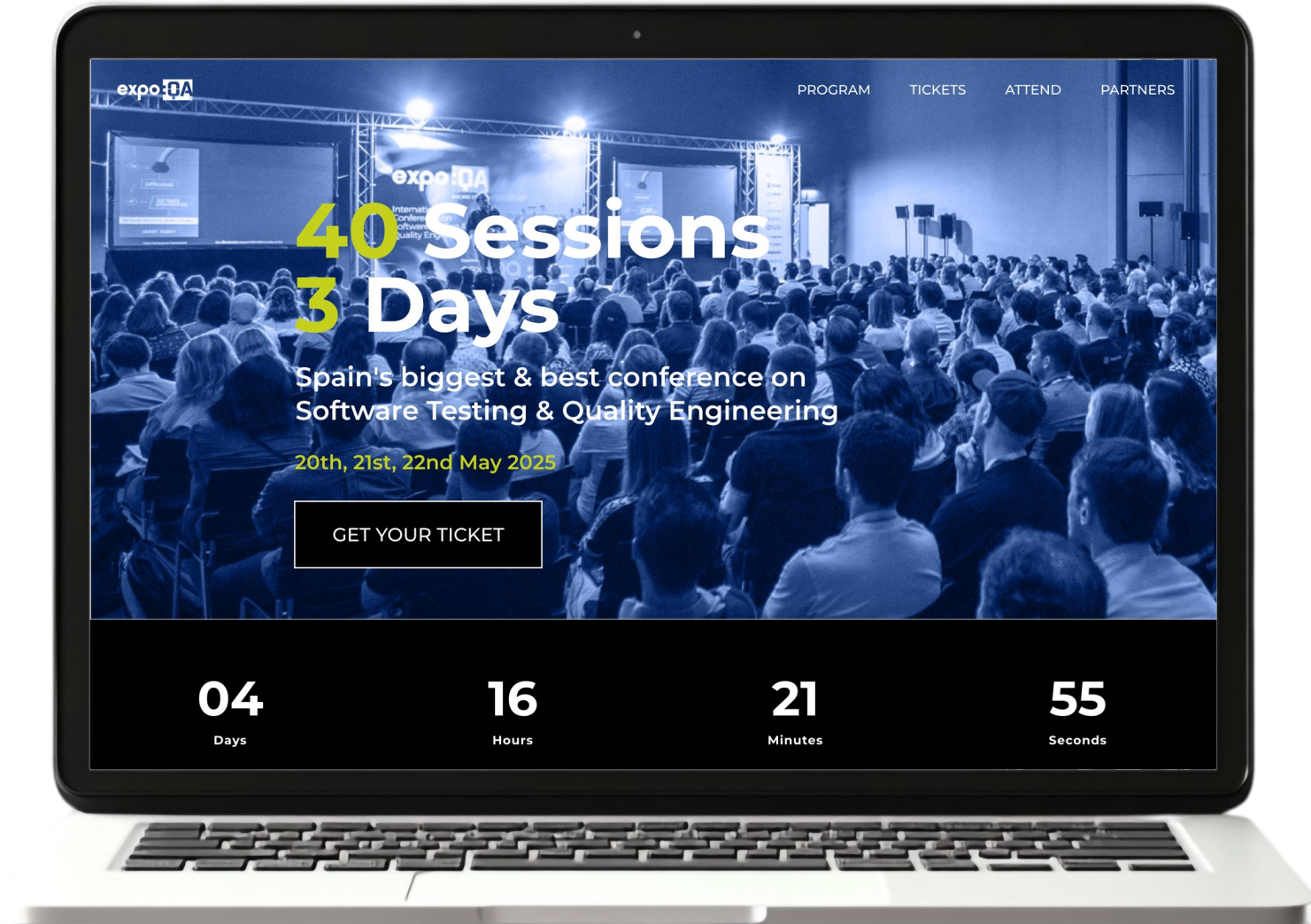
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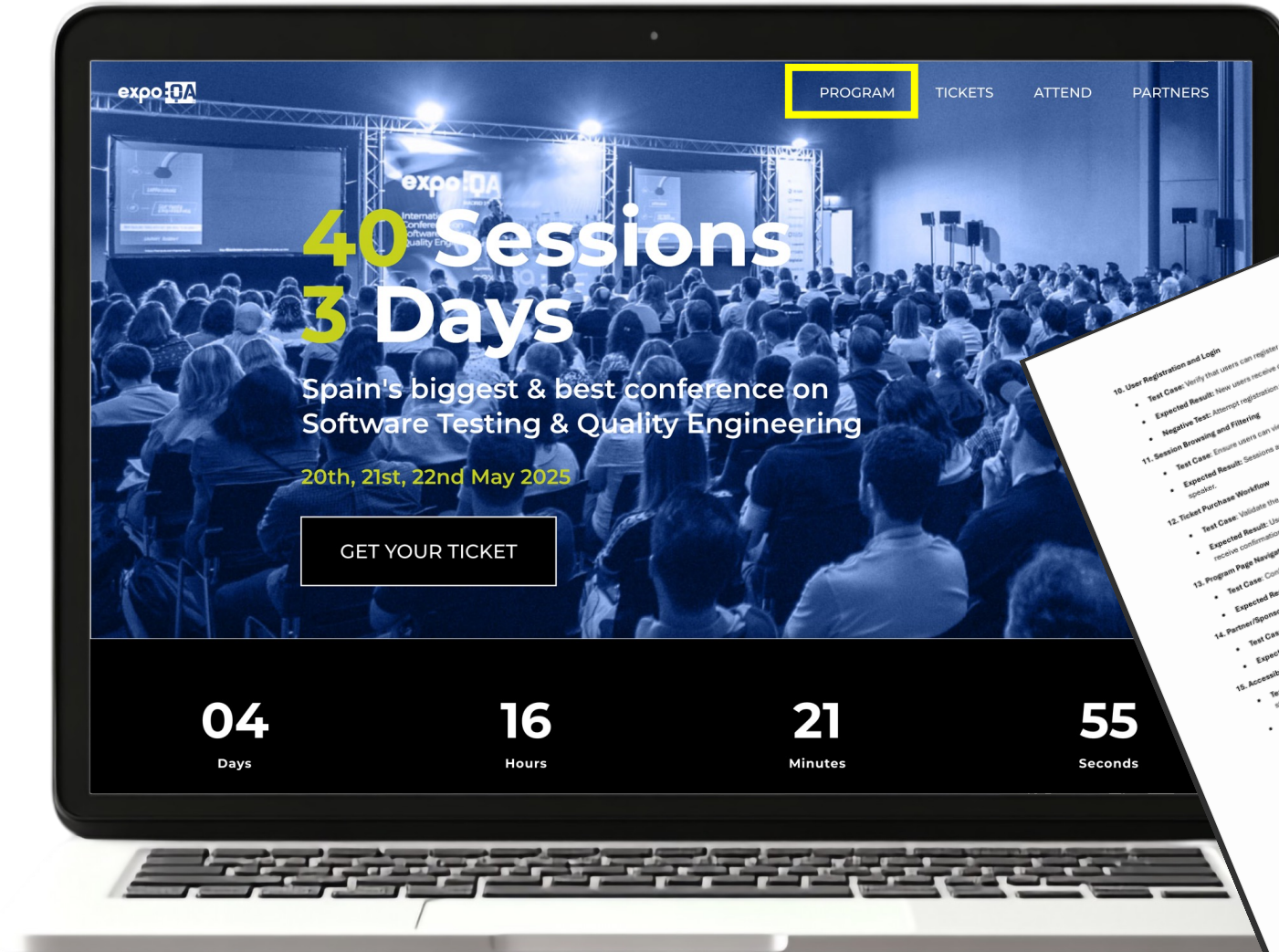
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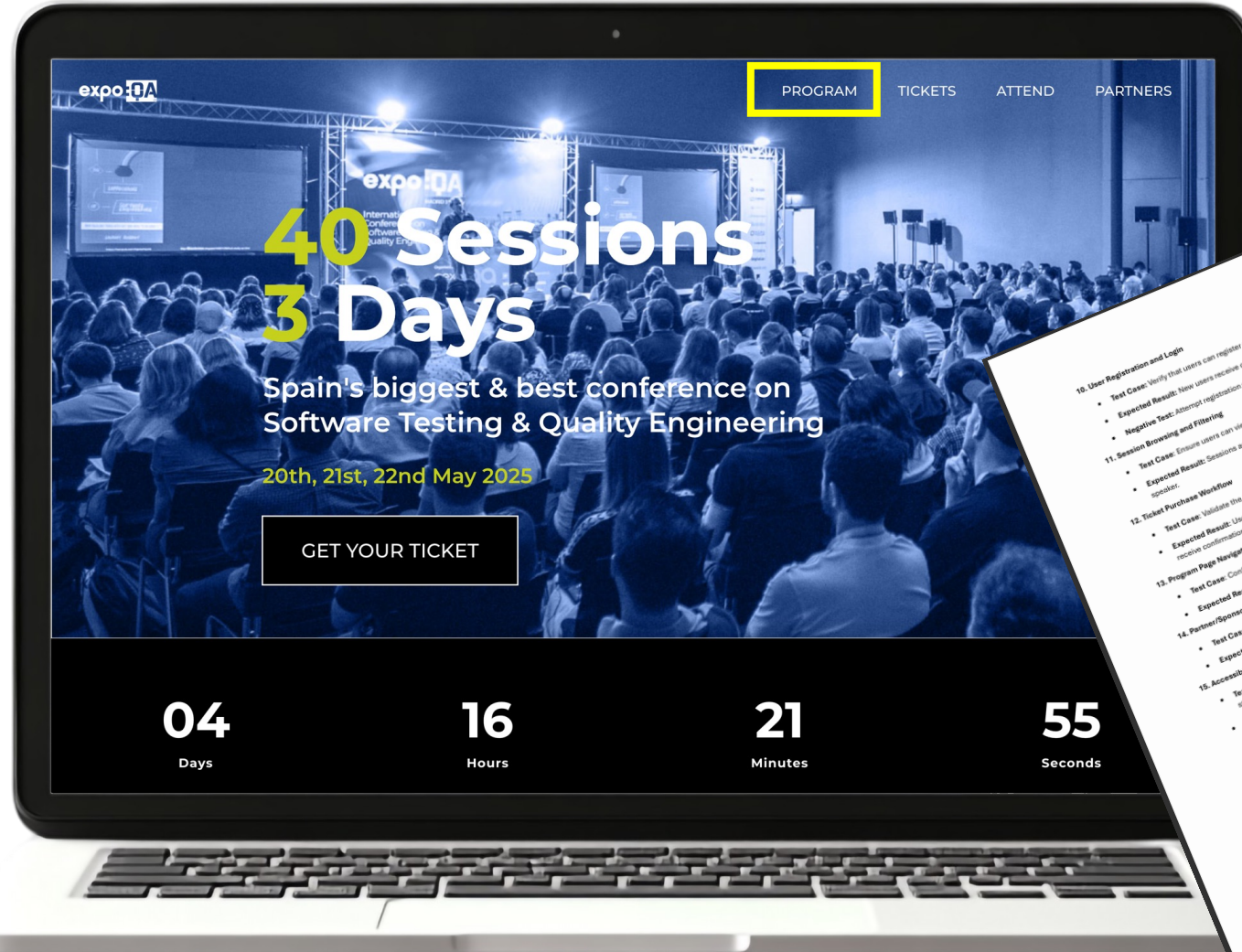
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How resilient is our pipeline to perturbations?

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## Functional Requirements - Capitle Consulting Website

RF-04: Job Opportunities Exploration

Based on: US-04 - IT professional seeking to explore job opportunities and find suitable positions.

Description:

The system must provide a comprehensive job vacancies section that allows IT professionals to explore and find relevant job opportunities.

Specific Requirements:

1. There must be a "Vacancies" or "Join Us" section accessible from the main menu.

2. The job vacancies page must include:

- An introduction to the company's work culture
- Benefits of working at Capitle Consulting
- Company values
- Types of available positions

3. Job vacancies must be organized by categories (development, QA, data, etc.).

4. Each vacancy must include:

- Job title
- Location
- Work modality (on-site, remote, hybrid)
- Job description
- Required skills and qualifications
- Responsibilities
- Specific benefits of the position

5. A filtering system must be included to search for vacancies by:

...

Acceptance Criteria:

- IT professionals can easily explore the available positions.
- The filtering system works correctly and displays relevant results.
- The application process is clear and simple.

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## Functionality Requirements - Critical Core Website

RF-04: Job Opportunity Evaluator

Based on: SU-04 - TI professionals seeking to explore job opportunities and find suitable positions.

Discipline:

The system must provide a comprehensive job vacancy search tool that allows TI professionals to explore and find relevant job opportunities.

Success Criteria:

1. The system must be a "Vacancies" or "Jobs" section accessible from the main menu.

2. The job vacancies page must include:

- An introduction to the company's work culture
- Benefits of working at Company Cognition
- Company values
- Type of available positions

3. Job vacancies must be categorized by categories (department, AQ, data, etc.).

4. Each vacancy must include:

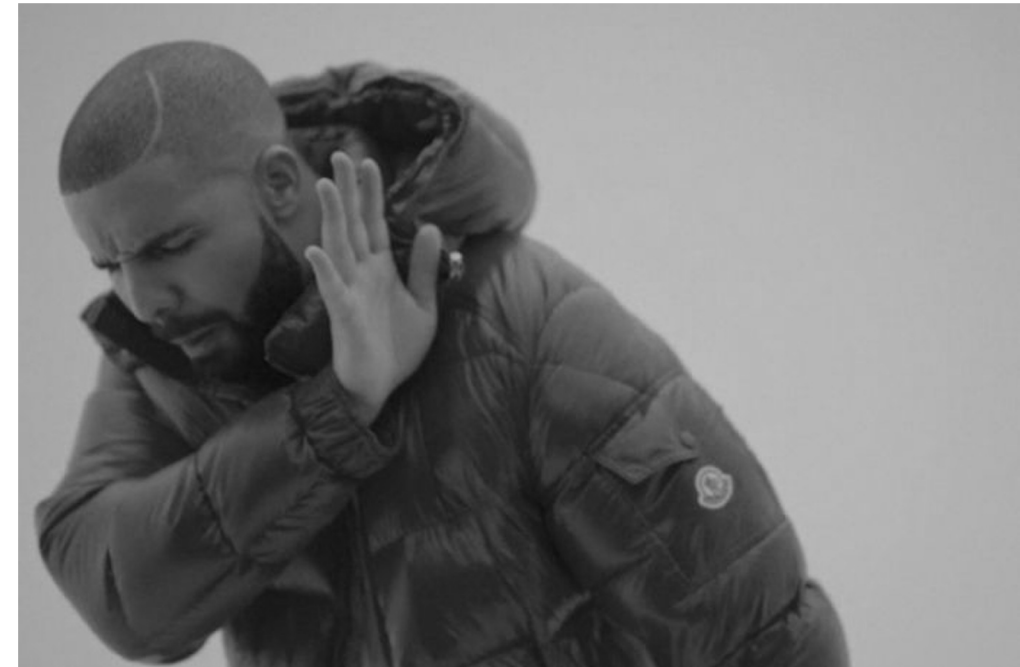
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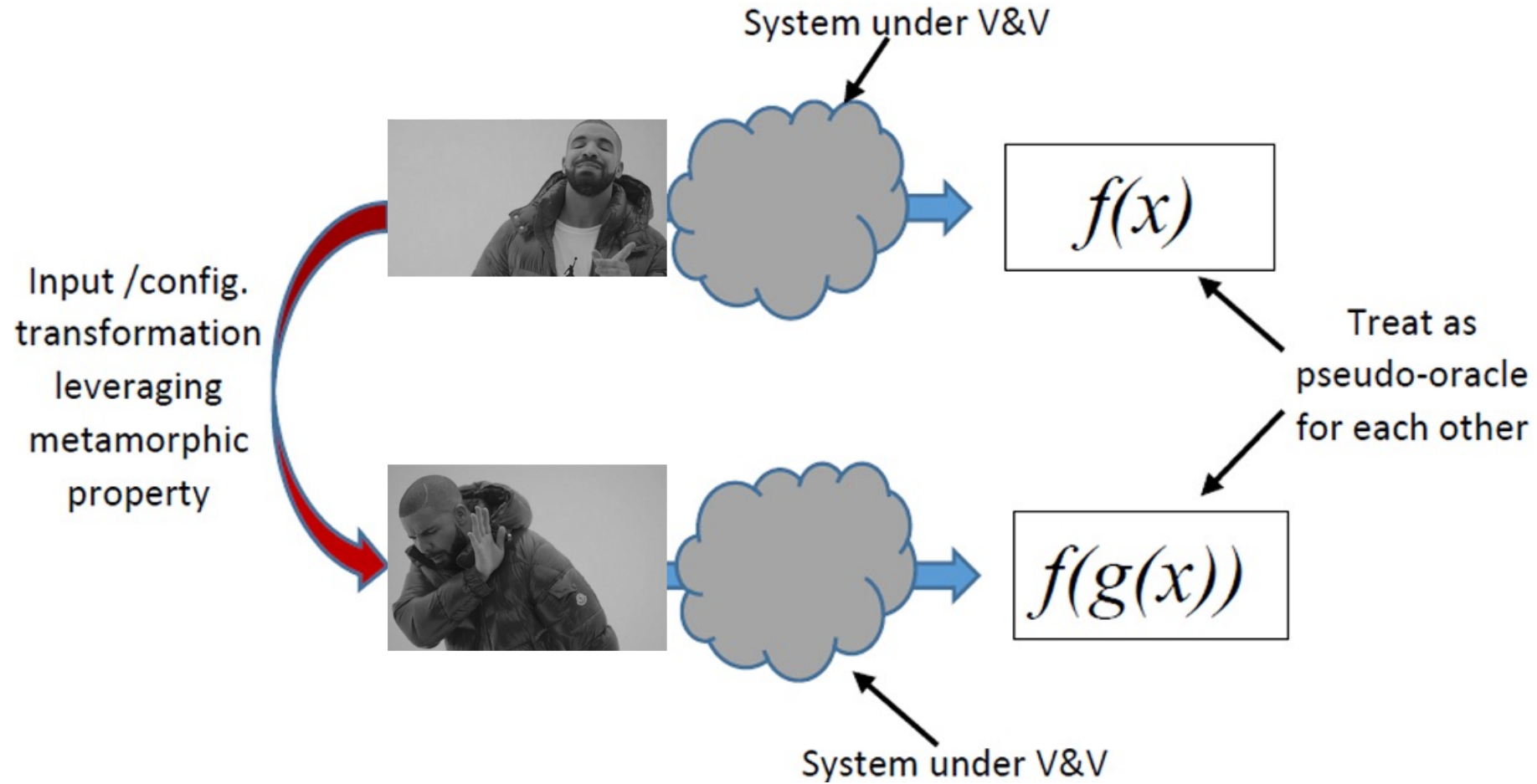
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# Metamorphic Testing



Raunak & Olsen (2015). Simulation Validation Using Metamorphic Testing

# Original

```gherkin

Feature: Job Opportunities Exploration

Scenario: Accessing the Job Vacancies Section

Given the user is on the main page of the Capitole Consulting website  
When the user navigates to the main menu  
Then the user should see a section labeled "Vacantes" or "Únete a Nosotros"

Scenario: Viewing Job Vacancies Page Content

Given the user is on the "Vacantes" page  
Then the user should see an introduction about the company's work culture  
And the user should see the benefits of working at Capitole Consulting  
And the user should see the company's values  
And the user should see the types of positions available

Scenario: Organizing Vacancies by Categories

Given the user is on the "Vacantes" page  
Then the user should see vacancies organized by categories such as development, QA, and data

Scenario: Viewing Details of a Job Vacancy

Given the user is viewing a specific job vacancy  
Then the user should see the job title  
And the user should see the location  
And the user should see the modality (onsite, remote, hybrid)  
And the user should see the job description  
And the user should see the requirements and necessary skills  
And the user should see the responsibilities  
And the user should see the specific benefits of the position

Scenario: Filtering Job Vacancies

Given the user is on the "Vacantes" page  
When the user applies filters by area of expertise, experience level, location, or technologies  
Then the user should see relevant job vacancies based on the applied filters

Scenario: Applying Directly to a Job Vacancy

Given the user is viewing a specific job vacancy  
When the user chooses to apply for the vacancy  
Then the user should be able to submit an application directly

Scenario: Sending a Spontaneous CV

Given the user is on the "Vacantes" page  
When the user chooses to send a spontaneous CV  
Then the user should be able to submit their CV for future opportunities

Scenario: Viewing Employee Testimonials

Given the user is on the "Vacantes" page  
Then the user should see testimonials from current employees

# Meta (char swap)

```gherkin

Feature: Job Opportunities Exploration

Scenario: Accessing the Vacancies Section

Given the user is on the main menu  
When the user selects the "Vacancies" or "Join Us" section  
Then the user should see the vacancies page

Scenario: Viewing Company Information on Vacancies Page

Given the user is on the vacancies page  
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Scenario: Viewing Organized Vacancies

Given the user is on the **vacancies** page  
Then the user should see vacancies organized by categories such as development, QA, data, etc.

Scenario: Viewing Detailed Vacancy Information

Given the user is viewing a specific vacancy  
Then the user should see the job title  
And the user should see the location  
And the user should see the modality (on-site, remote, hybrid)  
And the user should see the job description  
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Scenario: Using the Vacancy Filter System

Given the user is on the vacancies page  
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And the user should see the types of positions available

Scenario: Organizing Vacancies by Categories

Given the user is on the "Vacantes" page

Then the user should see vacancies organized by categories such as development, QA, and data

# Meta (char swap)

``gherkin

Feature: Job Opportunities Exploration

Scenario: Accessing the Vacancies Section

Given the user is on the main menu

When the user selects the "Vacancies" or "Join Us" section

Then the user should see the vacancies page

Scenario: Viewing Company Information on Vacancies Page

Given the user is on the vacancies page

Then the user should see an introduction about the company's work culture

And the user should see the benefits of working at Capitole Consulting

And the user should see the company's values

And the user should see the types of available positions

Scenario: Viewing Organized Vacancies

Given the user is on the **vacancies** page

Then the user should see vacancies organized by categories such as development, QA, data, etc.

...but what happens if we randomly replace words with synonyms within Functional Requirements?

# Original

``gherkin

Feature: Job Opportunities Exploration

Scenario: Accessing the Job Vacancies Section

Given the user is on the main page of the Capitole Consulting website

When the user navigates to the main menu

Then the user should see a section labeled "Vacantes" or "Únete a Nosotros"

Scenario: Viewing Job Vacancies Page Content

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# Meta (synonym replacement)

``gherkin

Feature: Job Platform Functionalities

Scenario: View available job positions

Given the user is an expert in technology

When the user accesses the job platform

Then the user should see a list of available job positions

Scenario: View job position details

Given the user is viewing a list of available job positions

When the user selects a job position

Then the user should see the job title, location, description, requirements, responsibilities, and benefits

Scenario: Filter job positions by expertise and location

Given the user is on the job platform

When the user filters positions by area of expertise and location

Then the user should see a list of job positions matching the criteria

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V S

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``gherkin  
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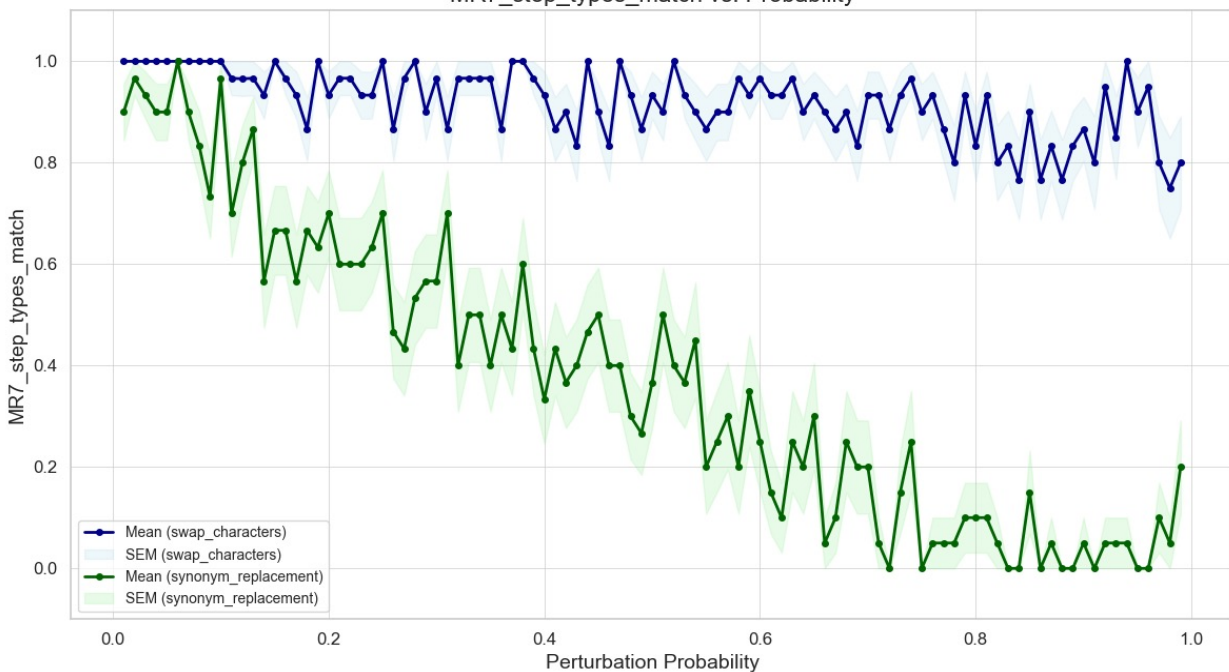


Measure similarity between original vs perturbed  
Gherkins as a function of a perturbation threshold!

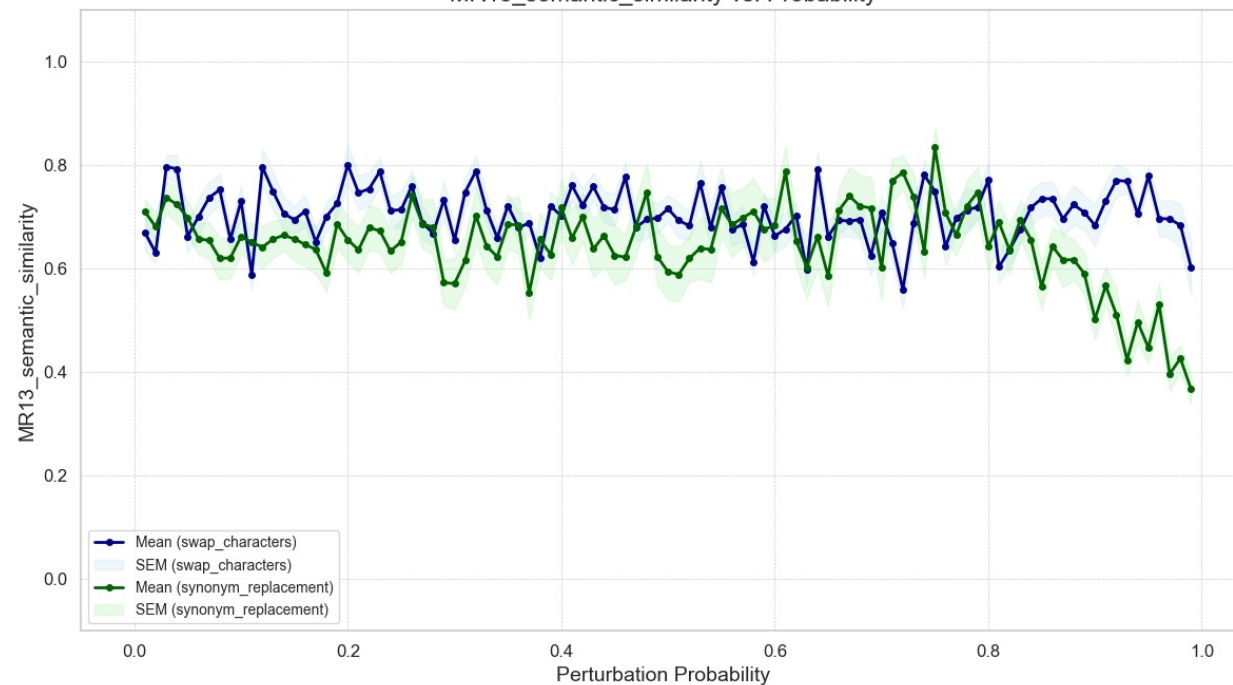
# Semantic Sim figures

character typos (swap)  
synonym replacement

MR7\_step\_types\_match vs. Probability



MR13\_semantic\_similarity vs. Probability



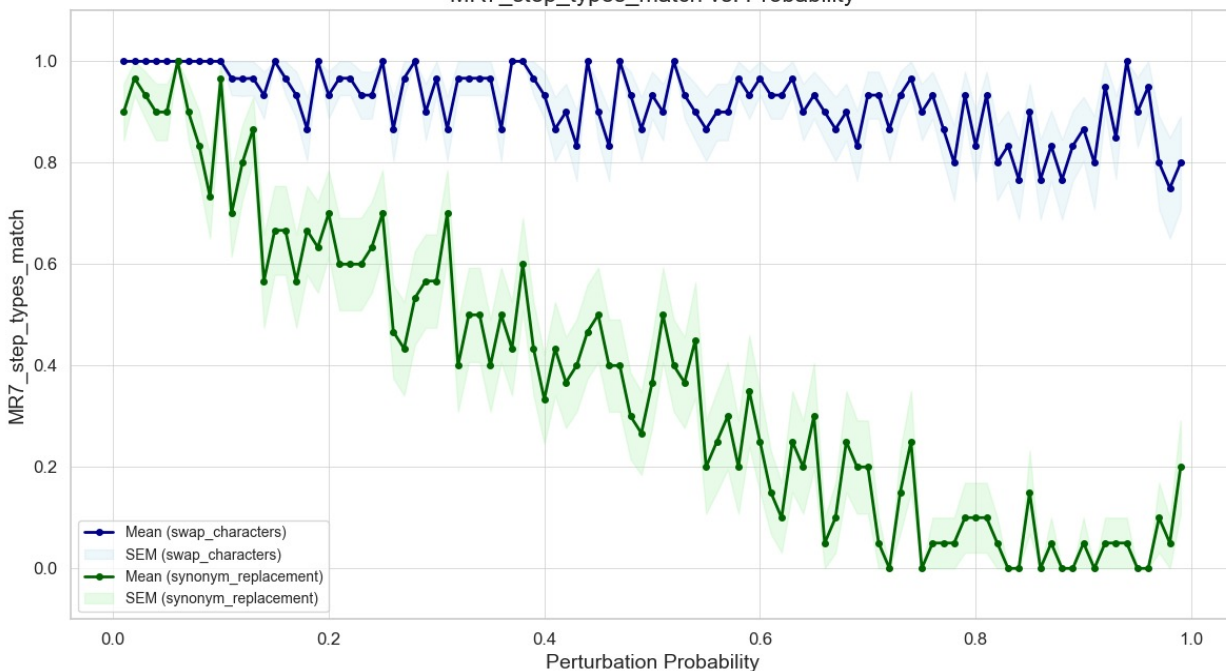
*In prep, Gurei et al., 2025*

\*gpt4o, testing more

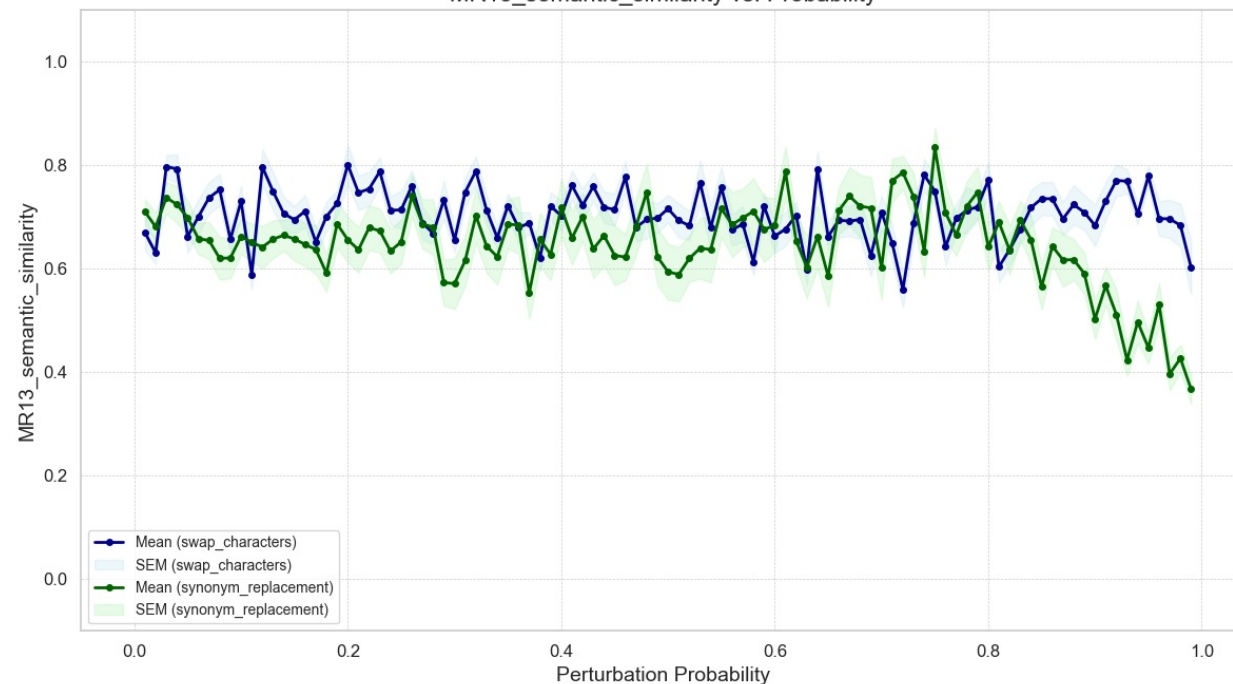
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MR7\_step\_types\_match vs. Probability



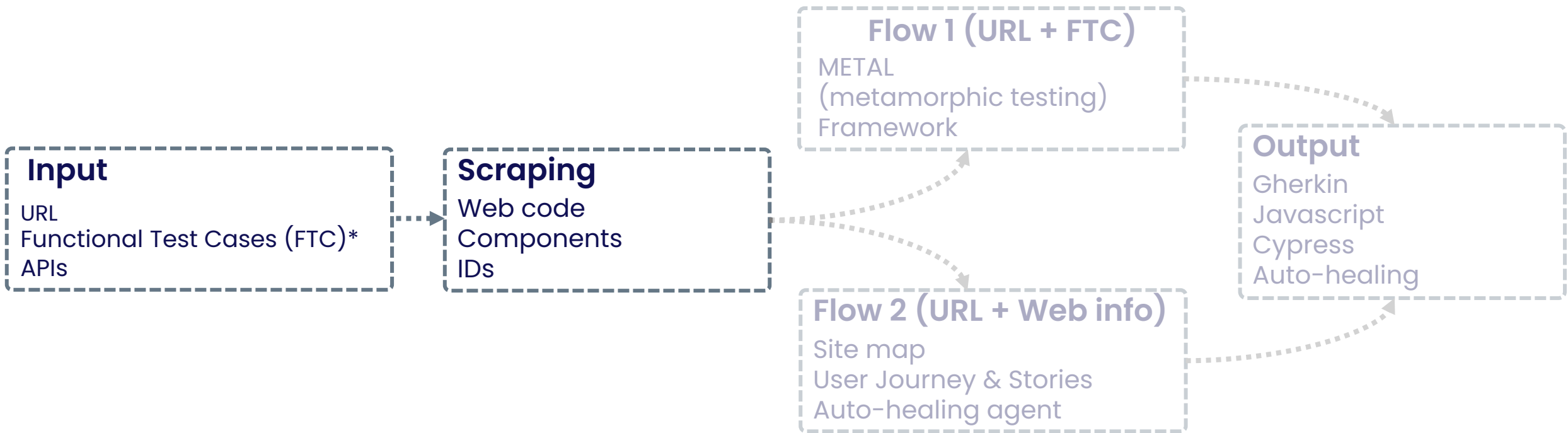
MR13\_semantic\_similarity vs. Probability

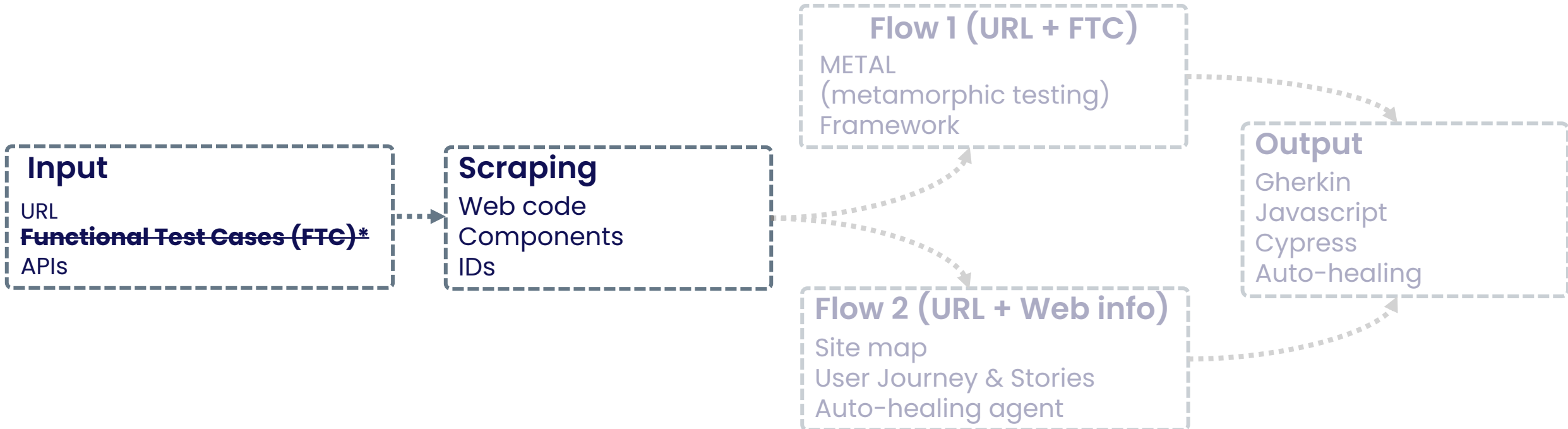


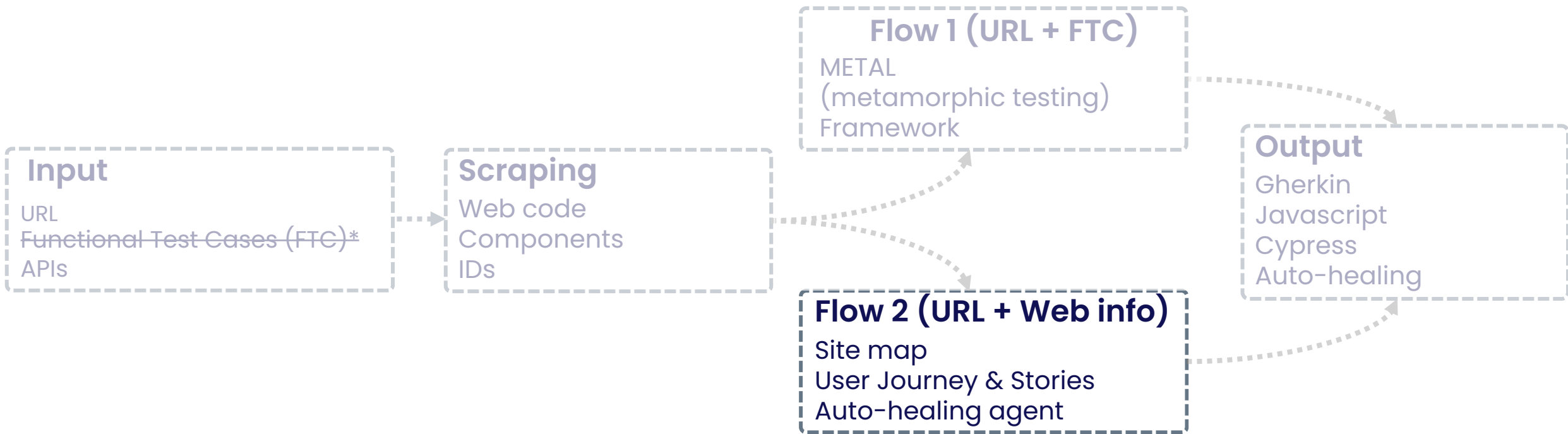
Models\* are resilient to **character typos (swap)**, not so much against **synonym replacement!**

*In prep, Gurei et al., 2025*

\*gpt4o, testing more

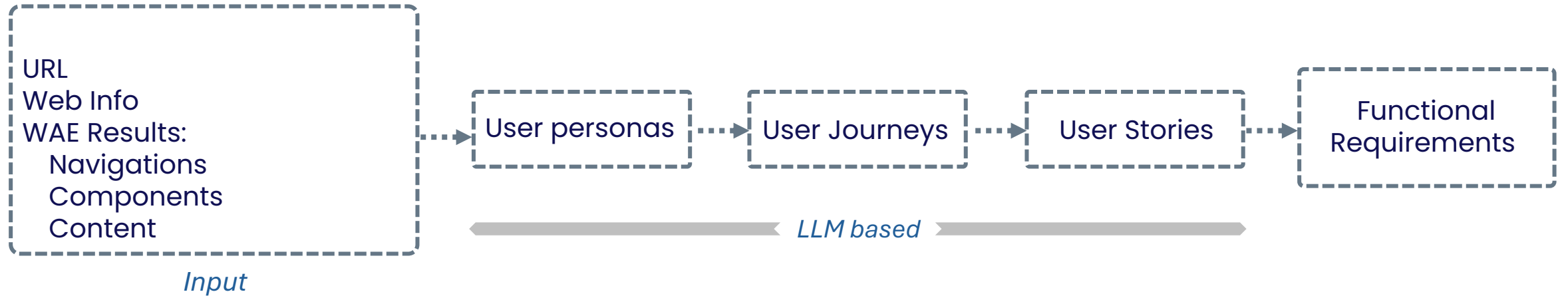






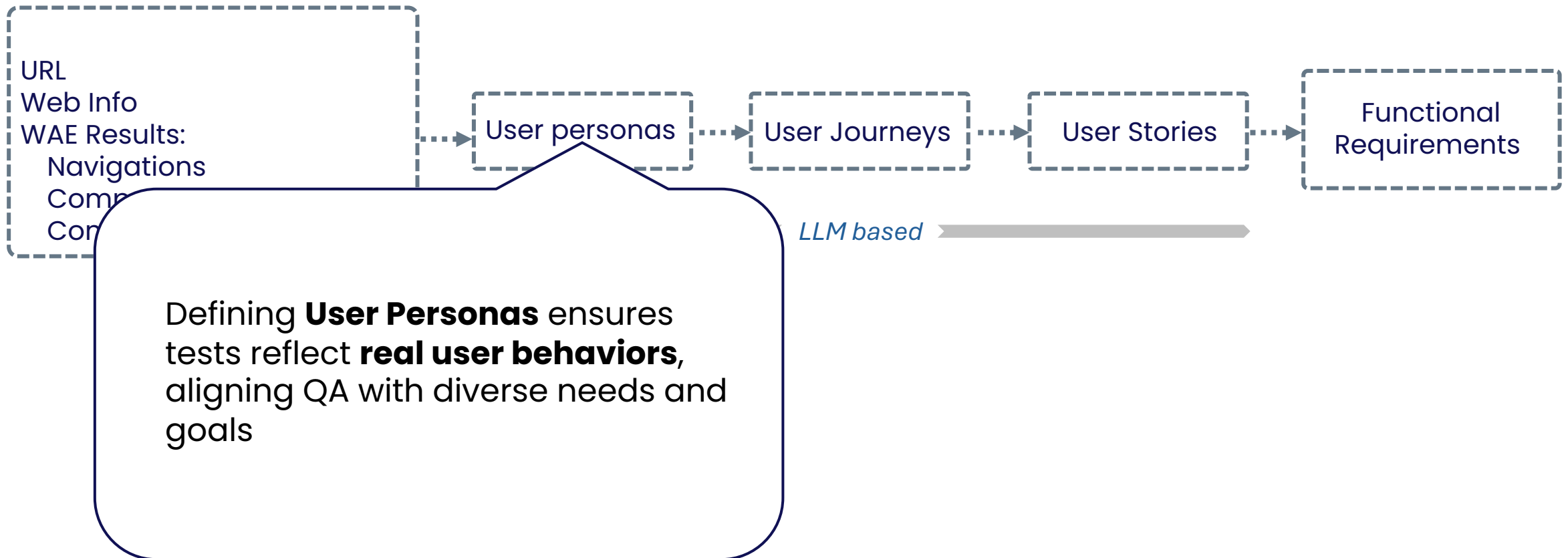
# Flow 2 (URL + Web info)

Generating FTC with Web Analysis Engine Results (WAE)



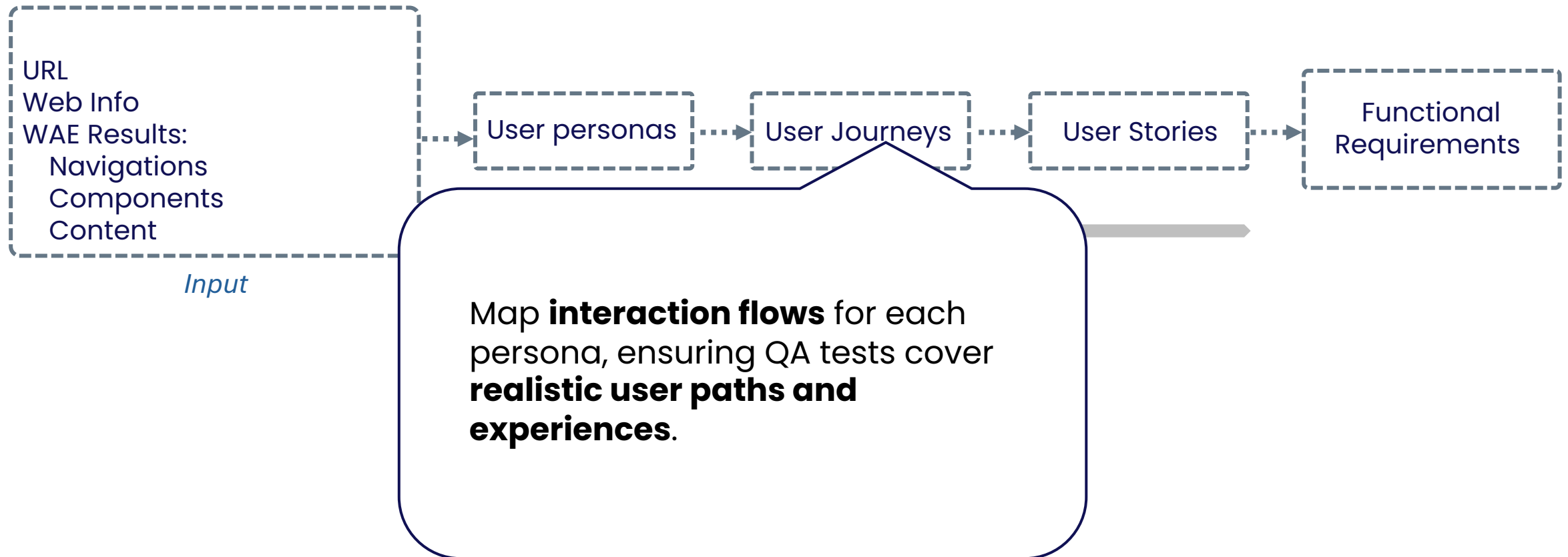
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Generating FTC with Web Analysis Engine Results (WAE)



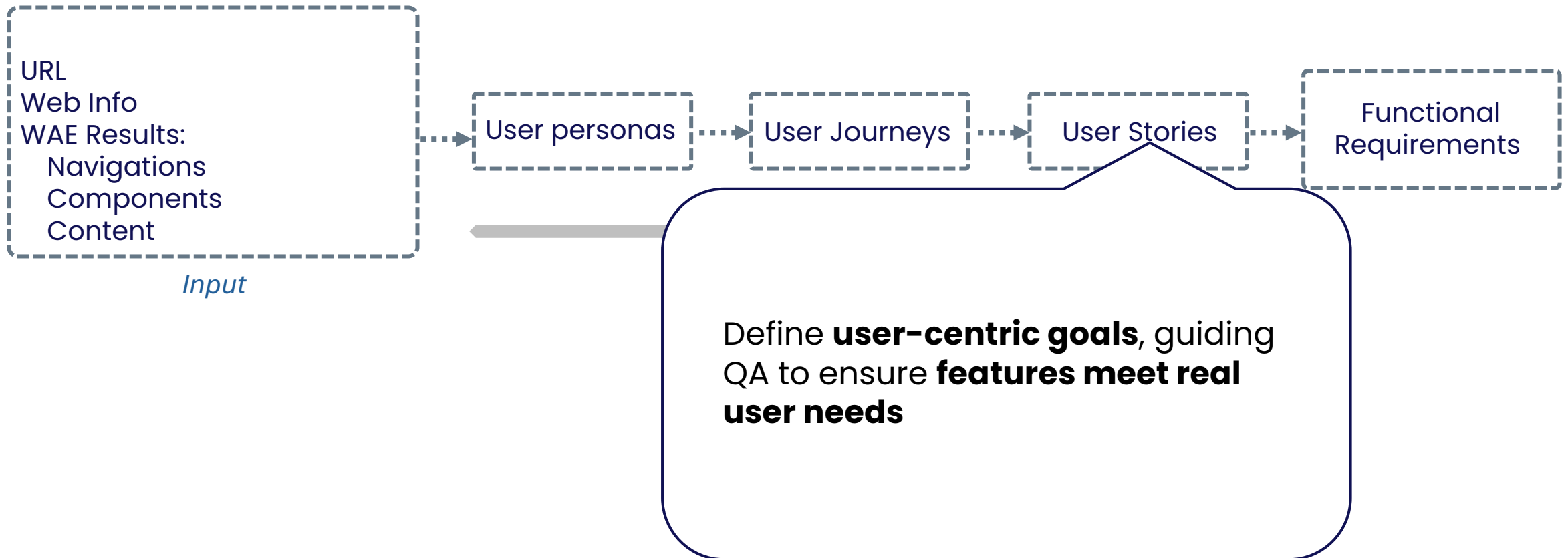
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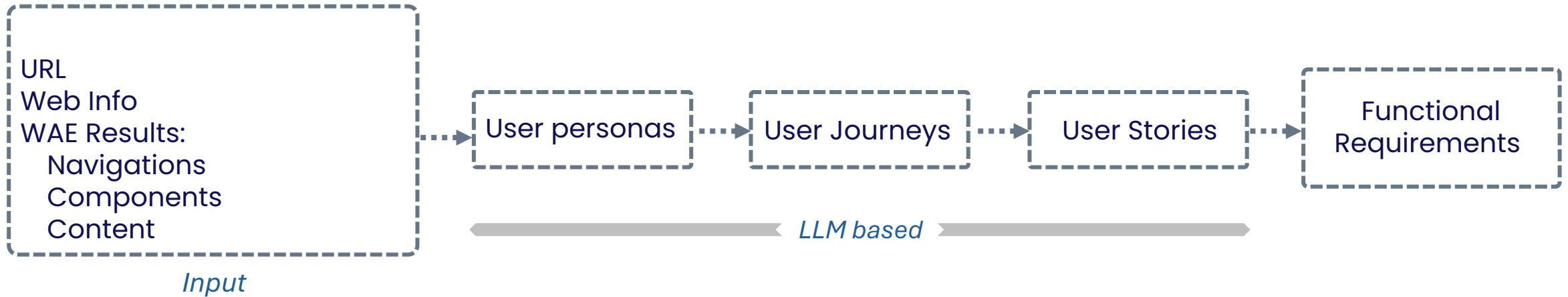
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# Flow 2 (URL + Web info)

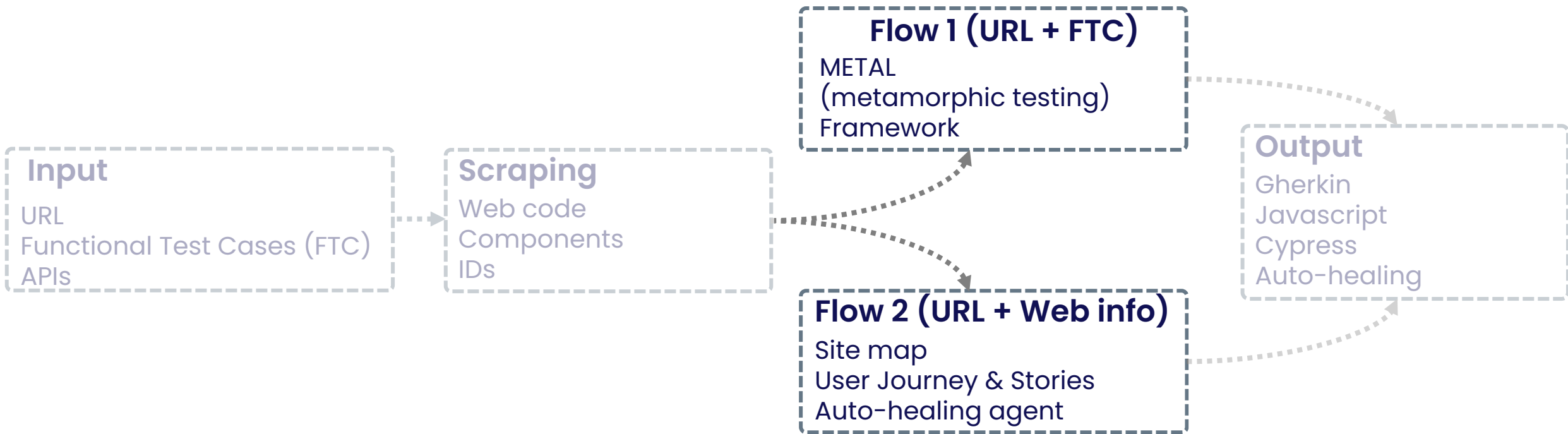
Generating FTC with Web Analysis Engine Results (WAE)

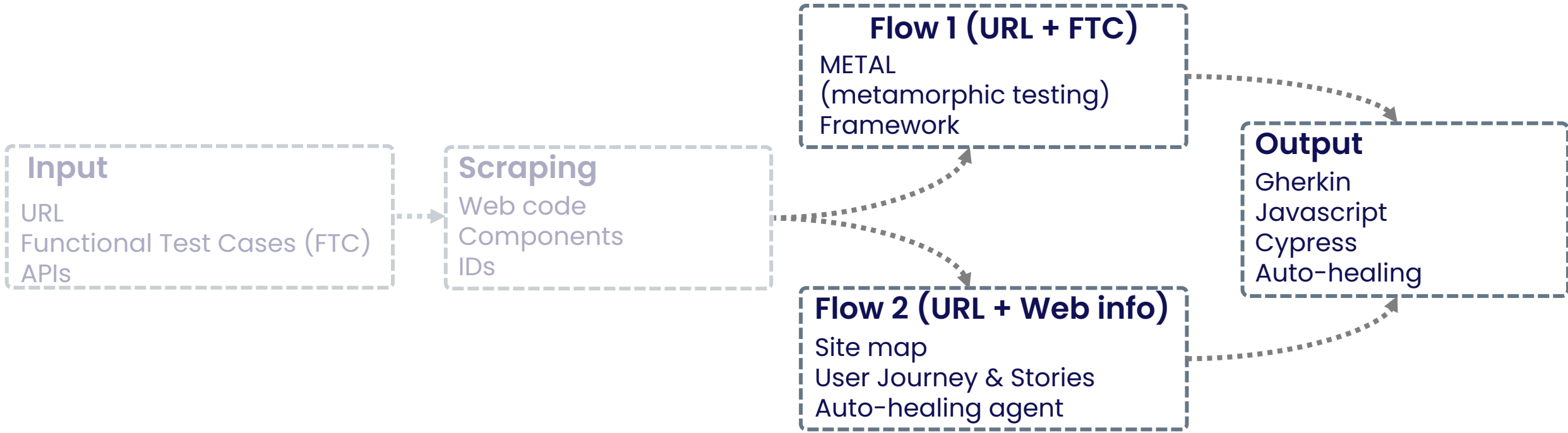


# Flow 2 (URL + Web info)

## FTC results

```
1 # Requisitos Funcionales para Capitole Consulting
2
3 ## Basado en el User Journey: UJ_001 (Búsqueda de Información Laboral y Envío de Candidatura General)
4
5 ### FR_001: Acceso a la página de Vacantes desde la Página de Inicio
6 * **ID:** FR_001
7 * **User Story Asociada(s):** US_001, US_002
8 * **User Journey y Paso:** UJ_001, Pasos 1 y 2
9 * **Descripción:** El usuario debe poder identificar y utilizar un enlace en la página de inicio para navegar a la sección de vacantes.
10 * **Precondiciones:**
11 * El usuario se encuentra en la Página de Inicio (`page_001: https://capitole-consulting.com/es/`).
12 * **Acciones del Usuario / Pasos del Sistema:**
13 1. El usuario revisa visualmente la Página de Inicio en busca de un enlace relacionado con empleo o carreras. (Corresponde a la búsqueda en UJ_001, Paso 1)
14 2. El usuario identifica un enlace con el texto "Descubre cómo es trabajar con nosotros" que apunta a `https://test.capitole-consulting.com/es/vacantes/`
15 0 alternatively, un enlace con el texto "Únete al equipo" que apunta a `https://www.linkedin.com/company/capitole-consulting/jobs/`.
16 Para este FR, nos centraremos en el enlace directo a la página de vacantes del sitio.
17 *Nota: `user_journeys.md` menciona un enlace "Vacantes", `page_001.md` tiene "Descubre cómo es trabajar con nosotros" hacia `/es/vacantes/`
18 y "Únete al equipo" hacia LinkedIn. Se prioriza el enlace interno.*
19 3. El usuario hace clic en el enlace "Descubre cómo es trabajar con nosotros" (o el que lleve a `/es/vacantes/`).
20 * **Resultados Esperados / Verificaciones:**
21 1. El sistema navega al usuario a la Página de Vacantes (`page_011: https://test.capitole-consulting.com/es/vacantes/`).
22 2. La URL del navegador cambia a `https://test.capitole-consulting.com/es/vacantes/`.
23 3. El título principal de la página, como "# Únete al futuro de la Tecnología" (de `page_011.md`), es visible.
24 4. Se muestra contenido relevante a oportunidades de empleo y la cultura de la empresa.
25 * **Elementos UI Involucrados (según markdown):**
26 * En `page_001.md`: Enlace con el texto "Descubre cómo es trabajar con nosotros" (destino `https://test.capitole-consulting.com/es/vacantes/`).
27 * En `page_011.md`: Título principal de la página (ej: "# Únete al futuro de la Tecnología").
```





# Workflow Output

Shared Outputs for Both Paths: **Gherkin Files**

```
1 # language: es
2 Feature: Búsqueda de Empleo en Capitole Consulting
3   Como un candidato potencial,
4   Quiero poder encontrar información sobre vacantes y enviar mi candidatura,
5   Para poder optar a oportunidades laborales en Capitole Consulting.
6
7   Background:
8     Given el usuario se encuentra en la Página de Inicio de Capitole Consulting
9
10  Scenario: FR_001 - Navegación a la página de Vacantes desde la Página de Inicio
11    When el usuario busca y hace clic en el enlace "Descubre cómo es trabajar con nosotros" para ir a vacantes
12    Then el sistema navega al usuario a la Página de Vacantes
13    And la URL del navegador es "https://test.capitole-consulting.com/es/vacantes/"
14    And el título principal de la página de vacantes es visible
15
16  Scenario: FR_002 - Exploración de información en la Página de Vacantes
17    Given el usuario se encuentra en la Página de Vacantes
18    When el usuario explora el contenido de la página de vacantes
19    Then la página muestra información sobre por qué trabajar en Capitole
20    And secciones como "Nuestros valores" y "Beneficios" son visibles
21    And se listan ejemplos de roles o áreas de contratación
22
```

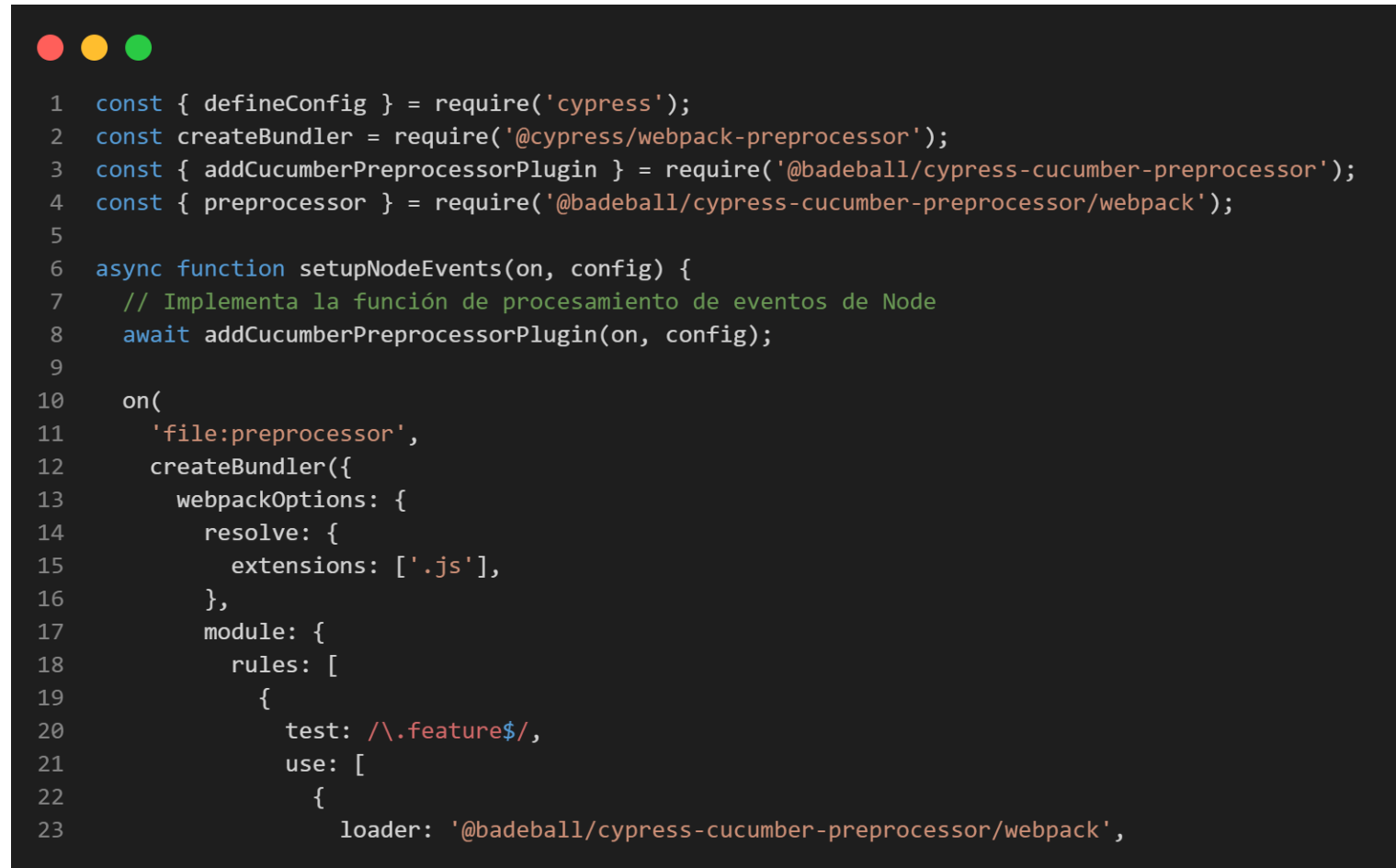
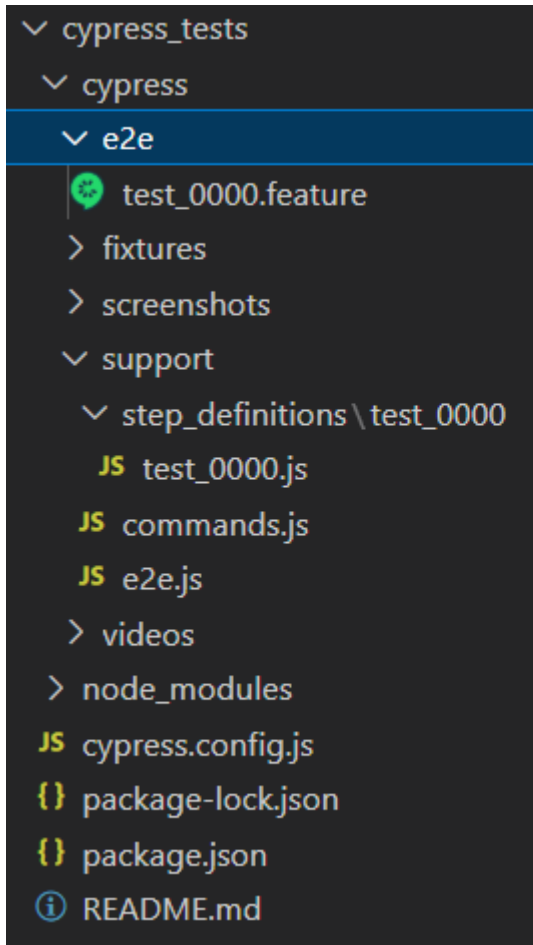
# Workflow Output

## Shared Outputs for Both Paths: **JavaScript Files**

```
1 Given('el usuario se encuentra en la Página de Inicio de Capitole Consulting', () => {
2   // First, try to accept cookies if the banner is present
3   // This assumes the cookie banner might not always be there or might be slow to appear
4   // Adding a small wait to ensure the page loads enough for the banner to appear
5   cy.visit(homepage_selectors.page_url);
6   cy.wait(1000); // Wait for potential cookie banner
7   cy.get('body').then(($body) => {
8     const cookie_accept_button_selector = 'button.cmplz-accept'; // More direct selector
9     if ($body.find(cookie_accept_button_selector).length) {
10      cy.get(cookie_accept_button_selector).click({ force: true }); // force true if it's overlaid
11    }
12  });
13 });
14
15 When('el usuario busca y hace clic en el enlace "Descubre cómo es trabajar con nosotros" para ir a vacantes', () => {
16   const linkText = "Descubre cómo es trabajar con nosotros";
17   // Find the element using its text content.
18   // The selector JSON indicates this button has the class "elementor-button" and specific text.
19   // A more robust selector might be needed if multiple buttons share this class.
20   // For now, we assume text is unique enough within its context.
21   const selector_data = homepage_selectors.interactive_elements.find(
22     el => el.attributes.text && el.attributes.text.trim() === linkText && el.action_target === "https://capitole-consulting.com/es/vacantes/"
23   );
24   if (!selector_data || !selector_data.attributes.href) {
25     throw new Error(`Link with text "${linkText}" and target "/es/vacantes/" not found in homepage_selectors.`);
26   }
27   // We'll use a selector that finds an 'a' tag with the specific href.
28   cy.get(`a[href="${selector_data.attributes.href}"]`).contains(linkText).click();
29 });
30
31 Then('el sistema navega al usuario a la Página de Vacantes', () => {
32   cy.url().should('include', '/es/vacantes/');
33 });
```

# Workflow Output

Shared Outputs for Both Paths: **Cypress Setup**



# Workflow Output

Exclusive to Path #2

The second path uniquely delivers a QA Autohealer Agent, enhancing test automation:

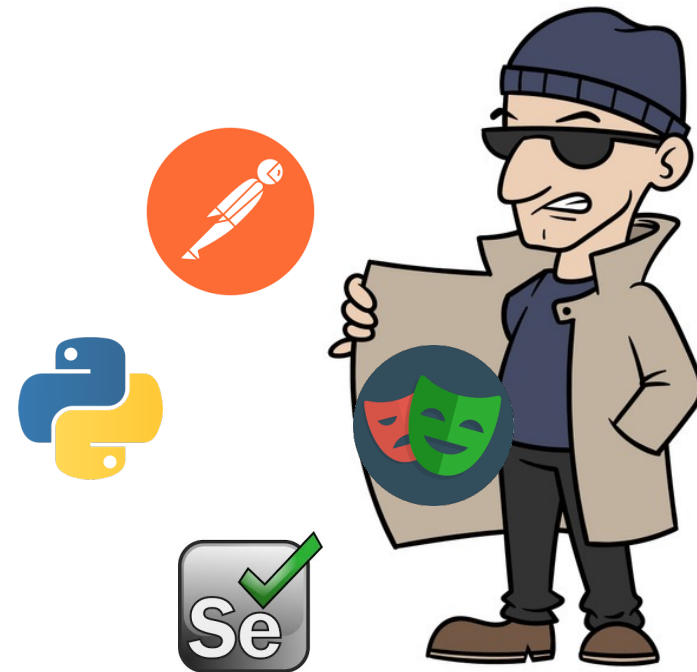
- **Test Execution:** Runs Cypress tests automatically.
- **Auto-Correction:** Fixes JavaScript files based on terminal feedback (other files under validation).

This agent optimizes QA by reducing manual intervention.

# Next Steps

- What if I prefer Playwright to Cypress?
- What if I don't work with JS but Python?
- What about Integration testing?

**We've got  
you covered!**



# Tahnk yuo!

**Victor Trujillo** 

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**Victor Saenger** 

R&D AI Lead at Capitole

victorsaenger@capitole-consulting.com



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# expo **QQA** 25

MADRID  
May 20th,  
21st & 22nd  
2025

Thank you for attending

[expoqqa.eu](http://expoqqa.eu)