UNIVERSITÀ DEGLI STUDI DI NAPOLI FEDERICO II

itee PhD information technology electrical engineering

DIETI UNINA


# Sergio Di Meglio


# Supporting the End-to-End Testing Process: Towards Reliable Web Applications

Tutor: Prof. Sergio Di Martino

co-Tutor: Dott. Fabio Scippacercola

Cycle: XXXVIII

Year:2023/2024

itee PhD information technology electrical engineering

FERVENTO

# Candidate's information

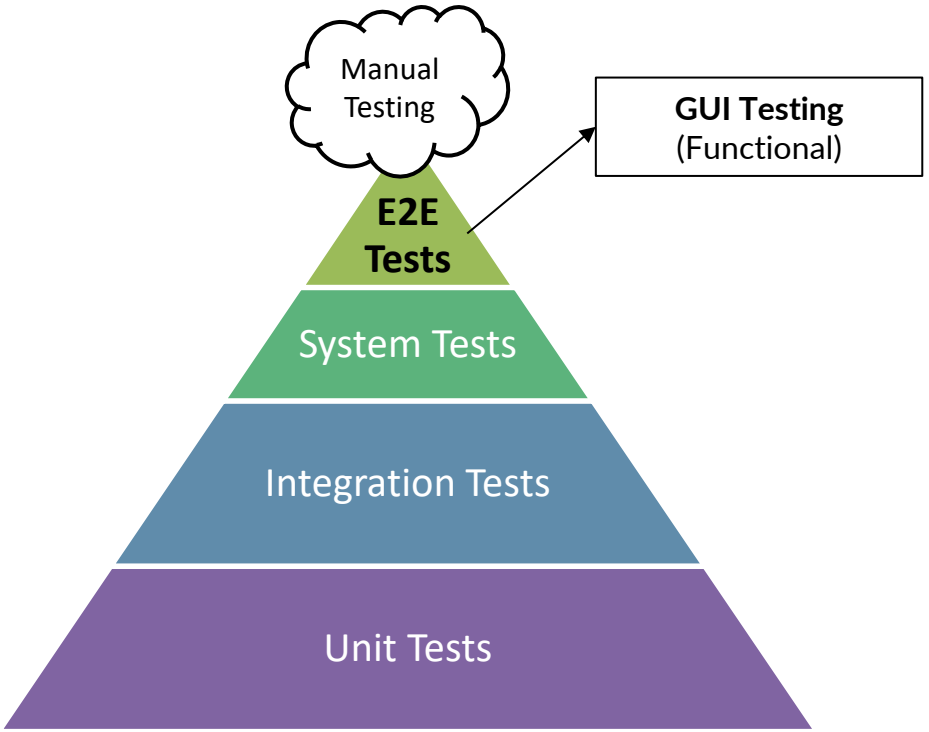
- **MSc degree**: Computer Science
- **PhD start date**: November 1, 2022.
- **Scholarship type**: PNRR - DM 352
- **Partner company**: Fervento srl
- **Periods abroad**: From 1 October 2024, I started my *6-month* period abroad at, *Software Language (SOFT) Lab*, Department of Computer Science, Vrije Universiteit Brussels, under the supervision of Prof. Coen De Roover.
- **Periods in company**: I typically spent three days (Monday, Tuesday and Wednesday) per week at the company, a total of about 144 days.

# Research filed of interest

End-to-End Testing in the context of Web applications:

**GUI TESTING**

- **Goal:** Test the system as a whole from the point of view of its intended end users.
- **How:** Simulate realistic user interaction with the GUI and verify system behavior.
- For web apps, it translates into simulating interaction with a browser.

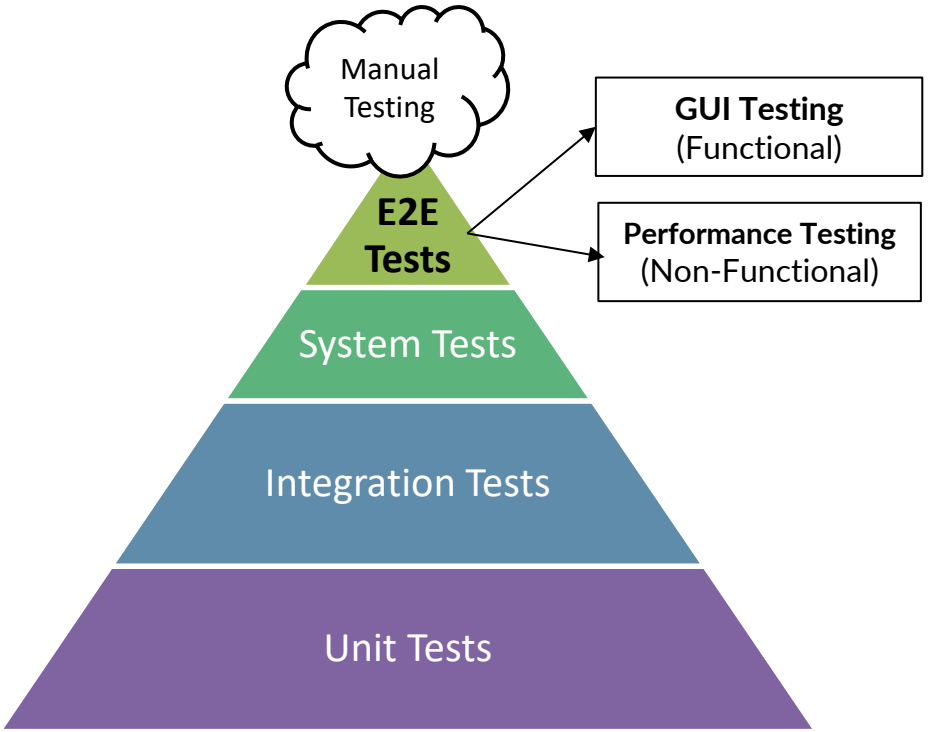


# Research filed of interest

End-to-End Testing in the context of Web applications:

**PERFORMANCE TESTING**

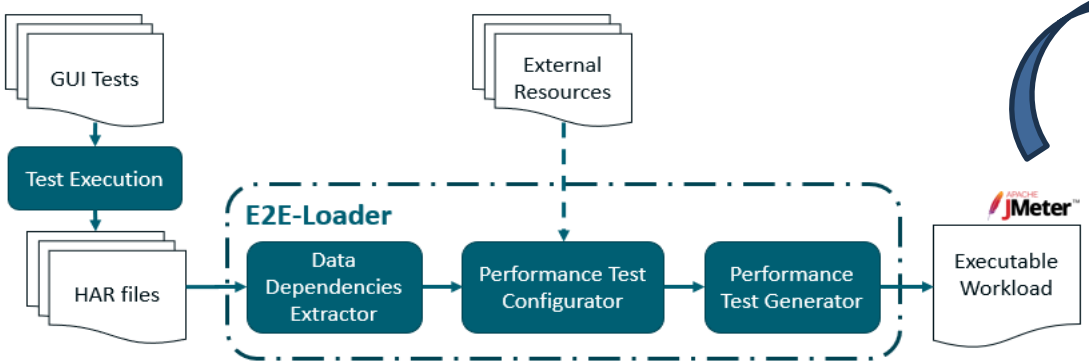
- **Goal**: Uncover load-related issues.
- **How**: Generate workloads for the system and monitor its behavior.
- For web apps, a workload consist of several concurrent user sending their own specific sequence of web requests.



# Research activity: Problem 1

- The automatic **generation of realistic workloads** has several limitations:
  - Requires specific skills.
  - Most of the work in literature exploits field data, such as logs.
  - Manual work needed to support emerging protocols and to manage data dependencies between requests.

**Key idea**: Leverage the data generated by existing GUI tests to support the generation of executable workloads




Pipeline approach overview


2023 IEEE Conference on Software Testing, Verification and Validation (ICST)

E2E-Loader: A Framework to Support Performance Testing of Web Applications

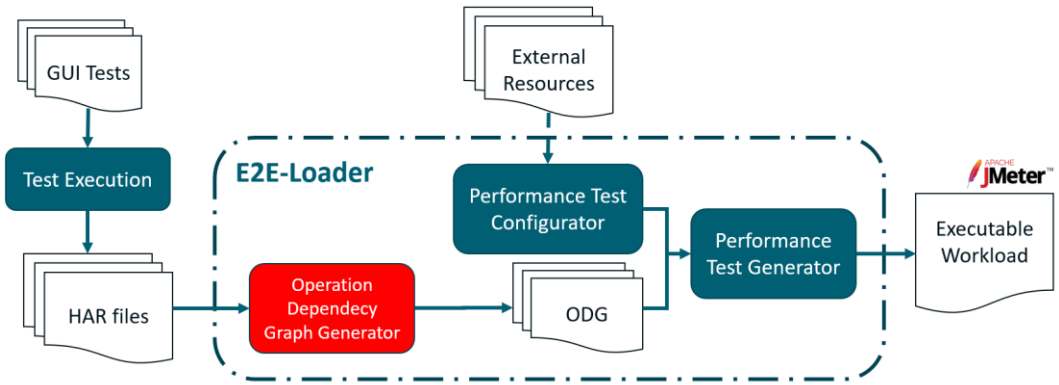
Ermanno Battista‡, Sergio Di Martino*, Sergio Di Meglio*, Fabio Scippacercola‡ and Luigi Libero Lucio Starace*
*Department of Electrical Engineering and Information Technology
Università degli Studi di Napoli Federico II, Naples, Italy
Email: {sergio.dimartino,sergio.dimeglio,luigiliberolucio.starace}@unina.it
‡Fervento srl
Email: {ermanno,fabio}@fervento.com

Published during the first year

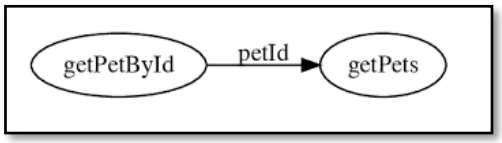
# Research activity: Problem 1

- The previous work suffers from two limitations:
  1. The *Data Dependencies Extractor module* is not completely automatic.
  2. The evaluation was done on a single web application provided by Fervento srl.

**Objective**: Introduce the *Operation Dependency Graph* as a way to explicitly model data dependencies among requests that can be automatically inferred by RET API interfaces.




New pipeline approach overview



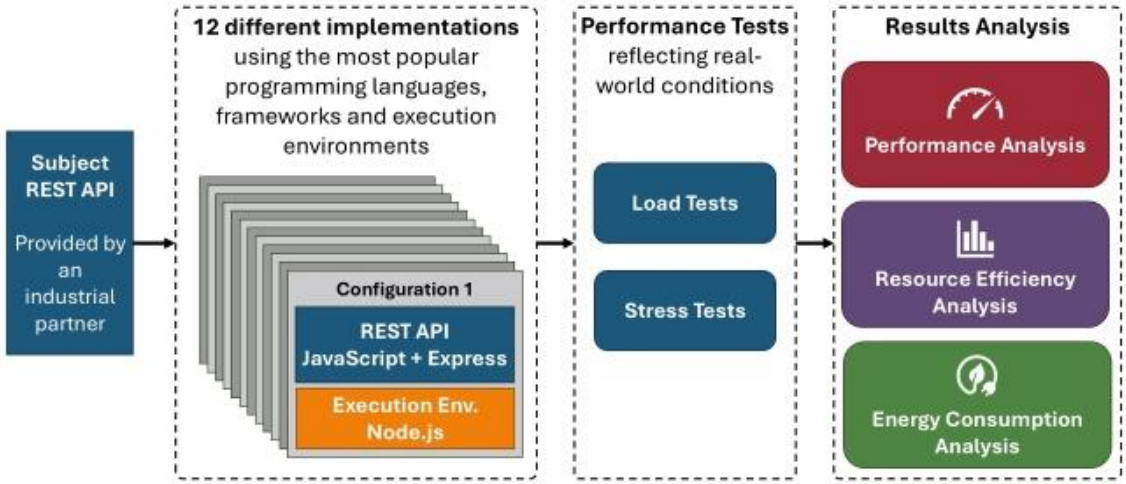

Example of a trivial ODG

# Research activity: Problem 2

- The initial development phase of a project is crucial, as the choice of technologies impacts the project quality. *What is the best framework to use? And with which execution environment (a traditional or an emerging one)?*

**First-year objective**: Provide a benchmark on a REST application, replicated with ***two*** framework and ***three*** environments, evaluating performance through response time metrics under identical loads.

**Second-year objective**:




Extended work overview (published on IEEE Access Journal)

**Starting a New REST API project? A Performance Benchmark of Frameworks and Execution Environments**

Sergio Di Meglio[1], Luigi Libero Lucio Starace[1] and Sergio Di Martino[1]

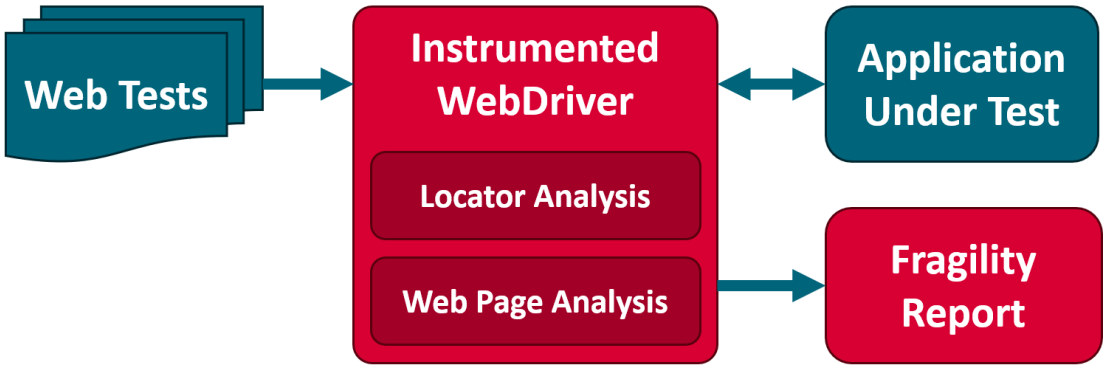
[1]Dept. of Electrical Engineering and Information Technology, Università degli Studi di Napoli Federico II, Naples, Italy

Published during the first year

# Research activity: Problem 3

- GUI tests are inherently **fragile** and tend to break down frequently even when minor changes are to the application structure.
- The few works in literature aimed at: 1) provide more robust locators 2) provide automatic repair approaches.

**Key idea:** Instead of attempting to repair tests after failure, this approach aims to identify the most fragile parts of the test code, based on information on how the test is written and how the pages visited by the test are structured, during the writing of the test itself.




Pipeline approach overview (published at EASE conference)

# Research activity: Problem 4

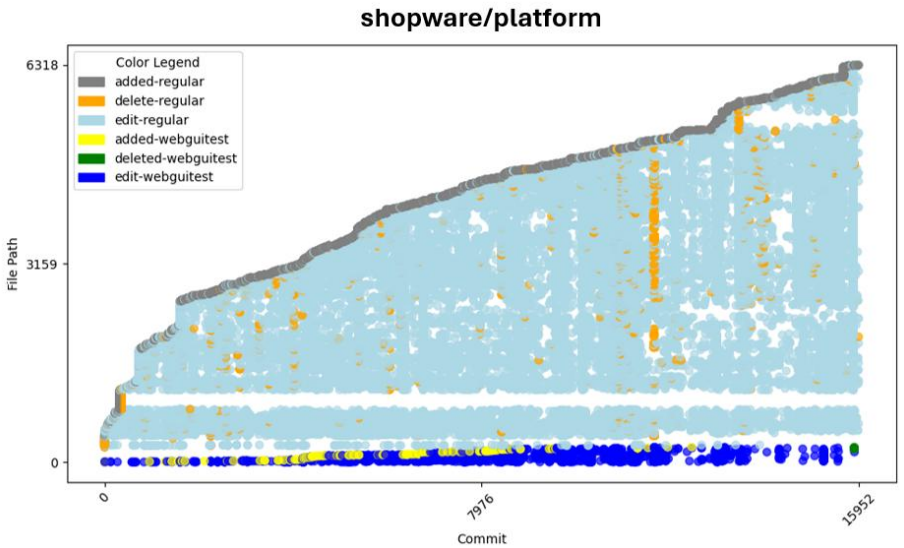
- From the research conducted (Problem 1 e 3), it is evident that there is a lack of collecting web project with GUI tests.

**Objective:** To fill these gaps, I perform a large-scale study on the adoption and use of Web GUI testing and its tools in the GitHub ecosystem.

The work aims to provide insights into:

1. the *characteristics of projects* that typically adopt this testing practice.
2. test *maintenance*, test *longevity* and test *abandonment*.
3. how test cases *co-evolve* with applications.

| REPOSITORY DESCRIPTION | N° REPOSITORIES |
|---|---|
| Non-trivial | 5563 |
| With browser-automation framework dependencies | 855 |
| With GUI Tests | 472 |




Example of Change History View of one the retrieved repository

# Summary of study activities

- **Course**:
  - ✓ Using deep learning properly
  - ✓ Software Testing
- **Conference/ events attended**:
  - ✓ International Conference on Evaluation and Assessment in Software Engineering (EASE) 2024, Salerno, Italy. *presenting author*
  - ✓ *Summer School on Security Testing and Verification 2024, Vrije Universiteit Brussel (VUB).*
- **Tutorship**:
  - ✓ Co-supervised of 7 thesis activities of a B.Sc in Computer Science student working on Software Engineering.
  - ✓ 20h hours lectures within B.Sc and M.sc courses in Computer Science.
- **Period abroad**:
  - ✓ Software Language (SOFT) Lab, Department of Computer Science, Vrije Universiteit Brussels, Belgium. (01/10/2024 – 01/04/2025)

# Research products

| | |
|---|---|
| [J1] | **Sergio Di Meglio**, L. L. L. Starace. “Evaluating Performance and Resource Consumption of REST Frameworks and Execution Environments: Insights and Guidelines for Developers and Companies”. IEEE Access Journal. Manuscript DOI: 10.1109/ACCESS.2024.3489892.<br>**status**: *published* |
| [C2] | **Sergio Di Meglio**, L.L.L Starace, “Towards Predicting Fragility in End-to-End Web Tests”, Proceedings of the 28th International Conference on Evaluation and Assessment in Software Engineering (EASE) 2024, Salerno, Italy.<br>**status**: *published* |
| [W3] | Marco De Luca, **Sergio Di Meglio**, Anna Rita Fasolino, L.L. L Starace and Porfirio Tramontana. “Automatic Assessment of Architectural Anti-patterns and Code Smells in Student Software Projects”, Workshop on evaLuation and assEssment in softwARe eNgineers’ Education and tRaining (LEARNER). Proceedings of the 28th International Conference on Evaluation and Assessment in Software Engineering (EASE) 2024, Salerno, Italy.<br>**status**: *published* |
| [C4] | **Sergio Di Meglio**, L. L. L. Starace, Valeria Pontillo, Ruben Opdebeeck, Coen De Roover and Sergio Di Martino. “Exploring the Prevalence and Maintenance of Web GUI Testing in the Wild: Findings from GitHub”. 22th International Conference on Mining Software Repositories (MSR) 2025, Ottawa, Canada.<br>**status**: *submitted* |
| [C5] | **Sergio Di Meglio**, Aniello Somma, L. L. L Starace, Fabio Scippacercola, Giancarlo Sperlì and Sergio Di Martino. “Large Language Models in the Travel Domain: An Industrial Experience” 40th ACM/SIGAPP Symposium On Applied Computing,2025, Sicily, Italy.<br>**status**: *submitted* |

# Thanks for the attention!

**Contact:**

sergio.dimeglio@unina.it
sergio@fervento.com