EFFICIENT AUTOMATED GUI TEST SCRIPT GENERATION AND CORRECTION

EAGLE

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1 Project Summary

Project Acronym	*EAGLE*
Project Title	*Efficient Automated GUI Test Script Generation and Correction*
Starting Date	*2024-01-01*
Duration	*12*

Abstract

Efficient Automated GUI Test Script Generation and Correction is a project aimed at revolutionizing the process of testing graphical user interfaces (GUIs) by leveraging automated techniques for test script generation and correction. The project is motivated by the increasing complexity of GUI-based applications and the need for efficient and reliable testing methodologies.

This project's main objective is to develop an innovative approach that greatly reduces the effort and time required for creating and maintaining test scripts for GUI testing. By automating the test script generation process, we aim to alleviate the manual effort involved in identifying and specifying test cases, improving the overall efficiency and effectiveness of GUI testing.

The project goes beyond the state-of-the-art by integrating intelligent algorithms and machine learning techniques to automatically identify GUI elements, infer their behaviors, and generate test scripts based on various test scenarios. Additionally, the project introduces a correction mechanism that detects and rectifies any errors or inconsistencies in the generated test scripts, ensuring their reliability and accuracy.

Through this project, we expect to achieve several significant outcomes. First, we anticipate a substantial reduction in the effort and time required for test script creation, enabling testing teams to focus on higher-value activities. Second, the automated approach will enhance test coverage by generating comprehensive test scripts that cover various GUI interactions and edge cases. Third, the project aims to improve the overall reliability of test scripts by identifying and correcting errors, reducing false positives and false negatives.

This project will contribute to the advancement of GUI testing practices, enabling software development teams to deliver high-quality GUI-based applications with reduced effort and increased confidence in their functionality.

2 Participants

No.	Name	Short name	Country	Project entry month	Project exit month
1	Eötvös Loránd University	ELTE	Hungary	1	12
2	University of Pisa	UNIPI	Italy	1	12
3	Technical University of Munich	TUM	Germany	1	12
4	Brainhub Sp. z o.o.	BRAINHUB	Poland	1	12
5	Dinarys Industry LLC	DINARYS	Germany	1	12

3 Budget Breakdown

Participant		Estimated eligible costs								Requested contribution (€)
No.	Short name	Effort (PM)	Personnel cost (€)	Subcon-tracting (€)	Direct costs (€)			Indirect costs (€)	Total costs (€)	
					Travel	Equipment	Other			
1	ELTE	38	102,702.7	0	55,850.00	150.00	0	39,675.67	198,378.3	138,864.85
2	UNIPI	40	183,783.7	0	27,610.00	75.00	0	52,867.19	264,335.9	185,035.17
3	TUM	48	233,513.5	0	46,680.50	115.00	0	70,077.25	350,386.2	245,270.38
4	BRAINHUB	12	48,648.65	0	0	32.00	0	12,170.16	60,850.81	42,595.56
5	DINARYS	27	102,162.1	0	0	48.00	0	25,552.54	127,762.7	89,433.89

4 Workplan

4.1 List of Work Packages (WP)

No.	Title	Type of activity	Lead beneficiary short name	Person-months	Start month	End month
WP1	Project management	MGT	ELTE	24	1	12
WP2	Study of weights for GUI element similarity	RTD	UNIPI	10	2	6
WP3	Testing newer version of FTPK	RTD	BRAINHUB	12	6	12
WP4	Tool upgrade from manual to automated testing	RTD	UNIPI	30	4	10
WP5	Training	Other	ELTE	4	10	12
WP6	Test script generation	RTD	TUM	48	1	12
WP7	Testing of script generation	RTD	DINARYS	27	3	12
WP8	Dissemination	Other	ELTE	6	1	12
WP9	Demonstration of results	DEM	ELTE	4	1	12
			Total	**165**		

4.2 List of Deliverables

No.	Title	WP No.	Lead beneficiary short name	Person-month	Type	Dissemi-nation Level	Delivery date
D1.1	Meeting report	WP1	ELTE	4	R	PP	ongoing
D1.2	Financial report	WP1	ELTE	5	R	CO	ongoing
D1.3	Face to face Management board meeting report	WP1	ELTE	3	R	PP	3,6,9,12
D1.4	Quality control reports	WP1	ELTE	12	R	PP	2,4,6,8,10,12
D2.1	Research inputs	WP2	UNIPI	2	R	PU	3
D2.2	Evaluation metrics	WP2	UNIPI	2	O	PU	4
D2.3	Experiment plan	WP2	UNIPI	3	O	PU	4
D2.4	Result analysis report	WP2	UNIPI	3	R	PU	6
D3.1	Test Plan	WP3	BRAINHUB	3	O	PP	8
D3.2	Test Cases	WP3	BRAINHUB	4	R	PP	10
D3.3	Test Execution Results	WP3	BRAINHUB	4	R	PP	11
D3.4	Summary Report	WP3	BRAINHUB	1	R	PU	12

D4.1	Requirement analysis	WP4	UNIPI	2	R	PP	5
D4.2	Implementation	WP4	UNIPI	18	P	PP	8
D4.3	Test plan and analysis	WP4	UNIPI	6	R	PU	8, 10
D4.4	Maintenance plan	WP4	UNIPI	2	O	PU	10
D4.5	Final Results	WP4	UNIPI	2	R	PP	10
D5.1	Training Program Outline	WP5	ELTE	1	O	PP	11
D5.2	Training Materials	WP5	ELTE	1	O	PP	11
D5.3	Training Reports	WP5	ELTE	2	R	PU	12
D6.1	Requirement analysis	WP6	TUM	2	R	PP	3
D6.2	Implementation	WP6	TUM	30	P	PP	10
D6.3	Test plan and analysis	WP6	TUM	8	R	PU	8, 12
D6.4	Maintenance plan	WP6	TUM	3	O	PU	12
D6.5	User documentation	WP6	TUM	3	O	PU	12
D6.6	Final Results	WP6	TUM	2	R	PP	12
D7.1	Test Plan	WP7	DINARYS	6	O	PP	5
D7.2	Test Cases	WP7	DINARYS	9	R	PP	9
D7.3	Test Execution Results	WP7	DINARYS	8	R	PP	ongoing
D7.4	Summary Report	WP7	DINARYS	4	R	PU	12
D8.1	Dissemination Plan	WP8	ELTE	3	O	PP	ongoing
D8.2	Dissemination Evaluation Report	WP8	ELTE	3	R	PP	ongoing
D9.1	Analysis report	WP9	ELTE	1	R	PU	12
D9.2	Demonstrations	WP9	ELTE	1	O	PU	12
D9.3	Presentations	WP9	ELTE	1	O	PU	12
D9.4	Communication Plan	WP9	ELTE	1	O	PU	12
			Total	**165**			

4.3 Work Package Description

WP No.	1
WP Title	Project management

Objectives

- Management and coordination of project
- Reporting to the Commission
- Manage project budget
- Setting internal and external communication tools
- Planning meetings
- Performing quality control check on project outputs
- Manage intellectual property issues

Description of Work

The scientific project manager will be responsible for the day-to-day operations, facilitating the communication and integration between science components and activities, and support the project bodies. The scientific project manager will be responsible for collating and editing the periodic scientific reports and facilitate synthesis and integration activities across the consortium.

The project office at ELTE will work in close cooperation with the co-ordinator and the finance officer will be responsible for the collation of management and financial reports and work with project partners on delivering timely, correct and complete management reports to the European Commission. In addition to the reporting tasks, the project office is responsible for the planning and organization of the project meetings and supports the WPs on Training and Dissemination in budgeting and finance.

Tasks:

Other:
- Setting internal and external communication tools

Meeting Reports (D1.1):
- Planning and holding meetings
- Writing summaries and reports of the meetings

Financial Reports (D1.2):
- Supervising the project budget
- Administrating the finances

Face to face Management board meeting report (D1.3):
- Discuss any issues or challenges what have arisen during the project
- Review the schedule and timeline
- Discuss and present major changes in the project like project scope, budget or timeline
- Overview the WP works and results

Quality control (D1.4):
- Revision of the work plan
- Review of deliverables

Other:
- Manage intellectual property issues

WP No.	2

WP Title	Study of weights for GUI element similarity

Objectives

- To define the research question and objectives for the study to establish a clear focus and direction for the research.
- To identify the appropriate research methodology, data collection techniques, and analytical tools to be used in the study.
- To design a robust study protocol that outlines the procedures and steps to be taken during the study.
- To collect and analyze data from the study using appropriate statistical and qualitative analysis methods.
- To draw conclusions from the study findings and provide recommendations for future research or practical applications based on the results.

Description of Work

The Work Package aims to conduct a comprehensive study on the relevance and impact of various GUI elements on user experience. This study will focus on identifying and analyzing the relationships between different GUI elements and determining the optimal use of these elements in the project to improve the user experience.

Tasks:

Other:
- Setting internal and external communication tools

Research inputs (D2.1):
- Identify the relevant source input
- Analyzing the input accuracy, relevance, and impact
- Organizing this input into distinct groups by its accuracy and relevance
- Writing summaries and reports of the meetings

Evaluation metrics (D2.2):
- Analyze the KPI indicators
- Analyze the connection between the various metrics
- Determine the weight of these metrics

Experiment plan (D2.3):
- Define research question
- Determine the keys of the research result measuring
- Plan the design plan
- Experiment data collection
- Implement the plan

Result analysis report (D2.4):
- Analyze the experiment result
- Connect the analyzed experiment results with the measure metrics
- Draw conclusion
- Create the report

WP No.	3
WP Title	Testing newer version of FTPK

Objectives

- Testing the newer version of FTPK tool (the FTPK is improved with the weights of the study of UNIPI)
- Presenting Results

Description of Work

The improved version of the FTPK tool will be tested by BRAINHUB with the help of ELTE and UNIPI.

Tasks:

Test Planning (D3.1):
- Define the test strategy and approach for testing the latest version
- Identify the test scenarios and test cases to be executed
- Determine the necessary testing resources, including tools and environments, applications, participants

Other:
- Set up the required test environment to replicate the production environment
- Install and configure the necessary softwares

Test Cases (D3.2):
- Design test cases that cover the various functionalities and features of the tool
- Ensure test cases are comprehensive, clear, and address the identified requirements
- Define test data and inputs required for executing the test cases

Test Execution Results (D3.3):
- Execute the designed test cases using the latest version of the tool
- Monitor and document the test execution process
- Report any defects or issues encountered during testing
- Collect test results and log any relevant information

Summary Report (D3.4):
- Generate test reports summarizing the testing activities, results, and findings
- Present the test results

WP No.	4

WP Title	Tool upgrade from manual to automated testing

Objectives

- To identify the manual testing processes that can be automated, and to select an appropriate test automation tool for the project.
- To design and implement automatic testing features that enhance the functionality and capabilities of the testing tool.
- To create reliable, maintainable, and scalable test automation scripts.
- To establish a process for monitoring and maintaining the automated test suite.
- To measure and report on the effectiveness of the automatic testing features.
- To ensure that the automatic testing features comply with project standards, guidelines, and best practices.
- To ensure that the automatic testing features are user-friendly, efficient, and effective in identifying and resolving software defects.

Description of Work

The work package to implement automatic testing features for a testing tool involves several tasks aimed at automating the manual testing processes of a software project.

Tasks:

Requirement analysis (D4.1):

- Reviewing the current manual testing processes to identify areas that can be automated and selecting an appropriate test automation tool.
- Designing and implementing automatic testing features that will enhance the functionality and capabilities of the tool.

Implementation (D4.2):

- Implement the new functionality by the design plan and the research results
- Creating reliable, maintainable, and scalable test automation scripts that cover all critical functional and non-functional requirements of the project.

Test plan and analysis (D4.3):

- Continuously improving the automatic testing features by incorporating feedback from project team members and stakeholders.
- Ensuring that the automatic testing features are user-friendly, efficient, and effective in identifying and resolving software defects.
- Analyze the results and feedbacks and provide ideas for the further upgrades and features
- Ensuring that the automatic testing features comply with project standards, guidelines, and best practices.

Maintenance plan (D4.4):

- Design maintenance plan for the implemented features, further upgrades and next tests

Final Results (D4.5):

- Publicite the result of the results of the newly implemented tool feature
- Analyze the effectiveness and impact of the new feature

WP No.	5
WP Title	Training

Objectives

- Create training materials for the educations
- Signing contracts
- Conducting educations for the usage of the new tools
- Authoring reports of the trainings
- Gathering feedback

Description of Work

The training about the new test script generation tools will be carried out by ELTE.

Tasks:

Training program outline (D5.1):

- Gather and analyze the data of future customers
- Assess the existing skill levels and knowledge gaps related to test script generation
- Develop a training program that addresses the identified needs and objectives
- Determine the training delivery format, whether it will be conducted in-person, online, or a combination of both
- Define the training curriculum, including the topics to be covered and the sequence of training modules

Other:

- Conclusion of contracts with customers

Training material (D5.2):

- Create training materials, such as presentation slides, user manuals, and hands-on exercises
- Create step-by-step instructions and examples to demonstrate the usage of the new test script generation tool
- Create practice exercises or simulations to allow participants to apply their learning in a controlled environment

Training Reports (D5.3):

- Conduct quizzes, assignments, or practical assessments to evaluate their knowledge that they received from the training
- Gather feedback from participants on the training program, content, and delivery

WP No.	6
WP Title	Test script generation

Objectives

- To identify the key functionalities and scenarios of the software application that need to be covered by the test scripts.
- To design and implement a test script generation framework or tool that automates the process of creating test scripts.
- To ensure the test scripts are comprehensive, covering positive and negative test cases to validate the software's functionality and performance.
- To integrate the test script generation process with the project's testing environment and test management tools.
- To validate the generated test scripts by executing them against the software application and verifying the expected results.
- To establish a process for reviewing and updating the test scripts based on feedback, changes in the software application, and evolving testing requirements.
- To provide training and documentation to the testing team on the usage and maintenance of the generated test scripts.

Description of Work

The work package to implement automatic testing features for a testing tool involves several tasks aimed at automating the manual testing processes of a software project.

Tasks:

Requirement analysis (D6.1):

- Review and analyze the project's functional and non-functional requirements to understand the scope and objectives of the test script generation process.
- Identify the key features, functionalities, and user scenarios.
- Define the inputs, outputs, and dependencies of each requirement.
- Prioritize the requirements based on their criticality and impact on the software.
- Identify any constraints or special considerations related to the requirements.

Implementation (D6.2):

- Define the structure and format for the test scripts, including naming conventions, organization, and documentation standards.
- Develop a systematic approach for generating test scripts, considering factors such as modularity, reusability, and maintainability.
- Implement the logic and validate the corresponding requirements.

Test plan and analysis (D6.3):

- Define the test objectives, goals, and scope.
- Identify the test scenarios and cases.
- Determine the appropriate test techniques and methodologies.
- Develop a test plan that outlines the overall approach, strategies, and timelines for test script generation, considering factors such as resource availability and dependencies.
- Analyze the test environment and infrastructure requirements necessary for executing the generated test scripts effectively.
- Identify the necessary test data and define the process for obtaining or generating the required data to support the test script execution.
- Determine the test metrics and measurements.

Maintenance plan (D6.4):

- Design maintenance plan for the implemented features, further upgrades, and next tests

User documentation (D6.5):

- Collect the user relevant information, features, constraints
- Write functional requirements
- Write user documentation
- Write non-functional requirements
- Write maintenance documentation

Final Results (D6.6):

- Publicite the result of the results of the newly implemented tool feature
- Analyze the effectiveness and impact of the new feature

WP No.	7
WP Title	Testing of test script generation

Objectives

- Testing the new tool, which generates automated test scripts from manual tests.
- Collaborating UNIPI at improving their tool
- Testing the new tool, which generates automated test from a GUI.
- Collaborating TUM at improving their tool
- Presenting Results

Description of Work

The testing of the test script generation tools will be carried out by DINARYS with the help and support of ELTE, TUM, and UNIPI. DINARYS will collaborate with our partners, who created the new tools – UNIPI and TUM. They author reports from the execution result and inform our partners.

Tasks:

Test Plan (D7.1):

- Define the test strategy and approach for testing the latest version.
- Identify the test scenarios and test cases to be executed.
- Determine the necessary testing resources, including tools and environments, applications, participants.

Other:

- Set up the required test environment to replicate the production environment.
- Install and configure the necessary softwares.

Test Cases (D7.2):

- Design test cases that cover the various functionalities and features of the tool.
- Ensure test cases are comprehensive, clear, and address the identified requirements.
- Define test data and inputs required for executing the test cases.

Test Execution Results (D7.3):

- Execute the designed test cases using the latest version of the tool.
- Monitor and document the test execution process.
- Report any defects or issues encountered during testing.
- Collect test results and log any relevant information.
- Prioritize and classify defects based on their severity and impact.

Other:

- Collaborate with the development team to resolve and retest the identified defects.

Summary Report (D7.4):

- Generate test reports summarizing the testing activities, results, and findings.
- Present the test results.

WP No.	8
WP Title	Dissemination

Objectives

- Writing Dissemination plan
- Promote the new tools on different platforms
- Engage with the audience
- Evaluate the dissemination

Description of Work

The dissemination, promotion and popularization of the test script generation tools will be carried out by ELTE.

Tasks:

Dissemination Plan (D8.1):

- Define the objectives and target audience for the dissemination activities
- Identify the key messages, highlighting the features and benefits of the test script generator tool
- Identify appropriate channels for dissemination, such as industry conferences, webinars, workshops, and social media platforms

Other:

- Design a visually appealing and user-friendly website or landing page dedicated to the tool
- Prepare demo videos or interactive presentations to highlight the tool's functionality and usage
- Schedule presentations or demonstrations at relevant conferences or events
- Organize webinars or workshops to provide hands-on experience and training on the tool's usage
- Leverage social media platforms, industry forums, and mailing lists to share information about the tool
- Engage with the audience by addressing their inquiries, providing additional information, and soliciting feedback.

Dissemination Evaluation Report (D8.2):

- Write summary report of the dissemination activities
- Evaluate the result of each activity

WP No.	9
WP Title	Demonstration of results

Objectives

- Identify the causes of test failures and develop an optimized repair methodology.
- Evaluate the effectiveness of the repair methodology in resolving test failures.
- Estimate the performance and efficiency of the methodology on a moderately complex web application.
- Present the demonstration plan, execute the demonstration, and analyze the results for improvement opportunities.

Description of Work

Performance estimation:

- Estimate the time required for each step of the methodology.
- Evaluate the efficiency of the methodology on a moderately complex web application.
- Consider the impact of hardware and software configurations on performance.

Roles and Responsibilities:

- **Research Team:** Conduct the experimental study, analyze test results, develop the repair methodology, estimate performance, and analyze demonstration results.
- **Technical Team:** Set up the testing environment, assist in methodology development, and support the demonstration's execution**.**

Deliverables:

- **Demonstration Plan Document:** Outlining the objectives, structure, content, and visuals of the demonstration.
- **Feedback and Observation Report:** Summarizing feedback and observations collected during the demonstration, including identified areas for improvement.
- **Demonstration Results Analysis Report:** Analyzing and evaluating the demonstration results, highlighting strengths, limitations, and potential improvements of the methodology.
- **Experimental Study Report:** Presenting the results and findings of the conducted experimental study, including the success rate of the repair methodology.

4.4 List of Milestones

No.	Name	Related WP(s)	Delivery date	Comments
MS1	Project Planning and Initiation	WP1	1	
MS2	Test script generation analysis completed	WP6	2	
MS3	Data Collection Completed	WP2	3	
MS4	Identification of dissemination channels and target audiences	WP8	3	
MS5	Weight Calculation Completed	WP2	4	
MS6	Development of a demonstration plan	WP9	4	
MS7	Test script generation design completed	WP6	5	
MS8	Test Plan Completed for test script generation testing	WP7	5	
MS9	Tool Analysis Completed	WP4	5	
MS10	Mid-term Review	WP1	6	
MS11	GUI Element Weight Study Completed	WP2	6	
MS12	Preparation of dissemination materials	WP8	6	
MS13	Tool Design Completed	WP4	6	
MS14	Test Scenarios and Cases Identified for test script generation testing	WP7	7	
MS15	Test Plan Completed	WP3	8	
MS16	Execution of the demonstration	WP9	8	
MS17	Submission of papers/posters to relevant conferences or journals	WP8	9	
MS18	Tool Implementation Completed	WP4	9	
MS19	Test script generation implementation completed	WP6	10	
MS20	Tool results created	WP4	10	
MS21	Training Plan Developed	WP5	11	
MS22	Final Review and Closeout	WP1	12	
MS23	Test Execution Completed	WP3	12	
MS24	Regression Testing Completed	WP3	12	
MS25	Training Delivery Completed	WP5	12	
MS26	Test script generation result created	WP6	12	
MS27	Test Execution Completed for test script generation	WP7	12	

MS28	Hosting of webinars or workshops to showcase project results	WP8	12	
MS29	Analysis and evaluation of the demonstration results	WP9	12	

4.5 Project Reviews

No.	Tentative timing	Planned venue of review	Comments, if any
RV1	7	Budapest	First Report
RV2	12	Budapest	Final Report

4.6 Project Efforts

WP \ Participant	ELTE	UNIPI	TUM	BRAINHUB	DINARYS	Total
Research, technological development (RTD) activities						
WP2		10				10
WP3				12		12
WP4		30				30
WP6			48			48
WP7					27	27
Total RTD	0	40	48	12	27	127
Demonstration (DEM) activities						
WP9	4					4
Total DEM	4					4
Management (MGT) activities						
WP1	24					24
Total MGT	24					24
Other activities						
WP5	4					4
WP8	6					6
Total OTHER	10					10
Total	38	40	48	12	27	165

5 Project Description

5.1 Scientific and Technical Quality

5.1.1 Concept and Objectives

Our vision and aim are to create tools which make the testing of the applications almost free, to make the software development more efficient and more cost-efficient.

Creating a test script generation tool presents various challenges that must be addressed to develop an effective and reliable solution. Addressing these challenges requires a combination of advanced algorithms, intelligent techniques, and a deep understanding of web application testing and AI programming. Continuous research, iterative development, and feedback from testers and users are crucial to overcome these, and create the tool, what we promise.

We have several work packages for the implementation of this project: (For more details, please see the 4.3 Work Package Description chapter)

5.1.1.1 WP1: Project management

The scientific project manager will be responsible for the day-to-day operations, facilitating the communication and integration between science components and activities, and support the project bodies.

The scientific project manager will be responsible for collating and editing the periodic scientific reports and facilitate synthesis and integration activities across the consortium.

The project office at ELTE will work in close cooperation with the coordinator and the finance officer will be responsible for the collation of management and financial reports and work with project partners on delivering timely, correct, and complete management reports to the European Commission. In addition to the reporting tasks, the project office is responsible for the planning and organization of the project meetings and supports the WPs (Work Packages) on Training and Dissemination in budgeting and finance.

5.1.1.2 WP2: Study of weights for GUI element similarity

This Work Package aims to conduct a comprehensive study on the relevance and impact of various GUI elements on user experience. This study will focus on identifying and analyzing the relationships between different GUI elements and determining the optimal use of these elements in the project to improve the user experience.

We are going to define the research question and objectives for the study to establish a clear focus and direction for the research; identify the appropriate research methodology, data collection techniques, and analytical tools to be used in the study; design a robust study protocol that outlines the procedures and steps to be taken during the study; collect and analyze data from the study using appropriate statistical and qualitative analysis methods; and finally, draw conclusions from the study findings and provide recommendations for future research or practical applications based on the results.

5.1.1.3 WP3: Testing newer version of FTPK

The testing of the improved version of the FTPK tool (the FTPK is improved with the weights of the study of UNIPI) will be carried out by BRAINHUB with the help and support of ELTE and UNIPI. They will also be presenting the results from the testing.

We are going to plan the test strategy, scenarios, and test cases; determine the testing resources, and tools; execute the tests; monitor the process; collect and report results; and finally summarize and present the results

5.1.1.4 WP4: Tool upgrade from manual to automated testing

This work package to implement automatic testing features for a testing tool involves several tasks aimed at automating the manual testing processes of a software project.

We are going to identify the manual testing processes that can be automated, and to select an appropriate test automation tool for the project; design and implement automatic testing features; create test automation scripts; monitor and maintain the automated test suite; measure and report on the effectiveness of the automatic testing features.

5.1.1.5 WP5: Training

The training of the new test script generation tools will be carried out by ELTE.

We are going to create training materials for the instructional purposes; sign contracts with the parties requiring training; conduct education for the usage of the new tools; author reports of the training sessions; and finally, gather feedback from the participants.

5.1.1.6 WP6: Test script generation

This work package to implement automatic testing features for a testing tool involves several tasks aimed at automating the manual testing processes of a software project.

We are going to identify the key functionalities and scenarios of the software application that need to be covered by the test scripts; design and implement a test script generation framework or tool that automates the process of creating test scripts; integrate the test script generation process with the project's testing environment and test management tools; validate the generated test scripts by executing them against the software application and verifying the expected results; establish a process for reviewing and updating the test scripts based on feedback, changes in the software application, and evolving testing requirements; and finally, provide training and documentation to the testing team on the usage and maintenance of the generated test scripts.

5.1.1.7 WP7: Testing of script generation

The testing of the test script generation tools will be carried out by DINARYS with the help and support of ELTE, TUM, and UNIPI. DINARYS will collaborate with our partners, who created the new tools – UNIPI and TUM. They author reports from the execution result and inform our partners.

We are going to test the new tool, which generates automated test scripts from manual tests; collaborate UNIPI at improving their tool; testing the new tool, which generates automated test from a GUI; collaborating TUM at improving their tool; and finally, summarize and present the testing results.

5.1.1.8 WP8: Dissemination

The dissemination, promotion and popularization of the test script generation tools will be carried out by ELTE.

We are going to write the dissemination plan; promote the new tools on different platforms; engage with the audience; and finally, evaluate the dissemination, with writing and representing a summary report.

5.1.1.9 WP9: Demonstration of results

We are going to outline and demonstrate Plan Document; summarize feedback and observations collected during the demonstration, including identified areas for improvement; analyze and evaluate the demonstration results, highlighting strengths, limitations, and potential improvements of the methodology; and finally, present the results and findings of the conducted experimental study, including the success rate of the repair methodology.

5.1.2 Progress Beyond the State-of-the-Art

Every of our new results are way above the state-of-the-art. There are not any tools out on the market which would provide even similar services to what we will offer.

The automated test script correction tool for fixing the location of changed web elements is going to be the most optimized and fastest tool. It is going to perform better than any tool known and used today for the same reason.

The robust test script generator (based on manual testing) does not have any competitors yet and does the test script generator based on GUI only. Both are unique in this field.

The robust test script generation works based on human manual testing. It generates test scripts in parallel to the human testing the application. In the meantime, it chooses the best conceivable way to save the location of the web element, so if there is going to be any change, the FTPK tool is more likely to find it, and correct the broken test script.

The automatic test script generator does not need much than the web interface itself. The tool is based on a trained Artificial Intelligence to generate scripts to test the functionalities of the application. It is the first step to fully automated testing in software development. It will not be necessary to use humans to test anymore.

5.1.3 Success Criteria and Research Indicators

The success criteria for the project include the development and implementation of working software tools, such as the merged solution combining Similo and DAA tools, to effectively detect and repair test case failures in a web application. The project aims to achieve improved performance, with a target increase of 120% compared to previous solutions. Additionally, accurate classification of failures based on not found web elements, with a classification accuracy increase of up to 200%, is another success criterion. The project also aims to achieve a repair success rate of at least 90% in accurately identifying and resolving issues causing test case failures. The use of fuzzy logic and algorithms is expected to optimize the testing process, reducing maintenance efforts, and improving the overall accuracy and efficiency of test automation.

Research indicators for the project include publications in relevant conferences or journals to document the methodology, experimental study, and findings. Patents may be filed for novel techniques or algorithms developed as part of the merged solution. Presentations at conferences and workshops can showcase the research methodology and results, while also fostering new collaborations with industry partners or research institutions. Training activities, such as webinars, workshops, or training sessions, can be conducted to disseminate knowledge and educate others on the developed methodology and its practical implementation. Project deliverables, such as technical reports, documentation, and demonstrations, will highlight the software tools developed and their capabilities.

5.1.4 S/T Methodology

5.1.4.1 Overall strategy and general description

Within this project, there are nine distinct work packages. Through the diligent efforts and collaborative endeavors of these work packages, our aim is to successfully accomplish the project's overarching goals. Each work package plays a vital role in contributing to the overall project objectives, emphasizing the importance of effective coordination and cooperation among them. By leveraging the expertise and contributions from each work package, we strive to achieve significant milestones and realize the major goals of the project.

There is an MGT package, five RTD, two Other and a DEM.

5.1.4.1.1 Project management

- Organization of general meetings and face-to-face meetings
- Publications
- Accumulate meeting reports

- Managing Financial questions and status
- Provide financial reports

5.1.4.1.2 Study of weights for GUI element similarity

- Collecting research papers and articles in the given area
- Evalution of the research results and measurements
- Create various kinds of metrics

5.1.4.1.3 Testing newer version of FTPK

- Create test plan
- Create test cases
- Execute test
- Evaluate the results of the test sessions

5.1.4.1.4 Tool upgrade from manual to automated testing

- Analyze the requirements
- Prepare the software for the feature implementation
- Implement the new automated test feature
- Provide additional test cases and plan
- Create a maintenance plan and documentation
- Publicite results

5.1.4.1.5 Training

- Collect training materials in various categories
- Assembly the outline of the training programs
- Publicite the results

5.1.4.1.6 Test script generation

- Analyze the requirements
- Prepare the software for the feature implementation
- Implement the new test script generation feature
- Provide additional test cases and plan
- Create a maintenance plan and documentation
- Publicite results

5.1.4.1.7 Testing of script generation

- Create test plan
- Create test cases
- Execute test
- Evaluate the results of the test sessions

5.1.4.1.8 Dissemination

- Plan the dissemination
- Create evaluation report

5.1.4.1.9 Demonstration of results

- Analyse the work package reports and results
- Demonstrate the results of the project
- Present the running of the project
- Plan the communication

5.1.4.2 Timing of work packages and their components

The timing and sequence of the work packages can be found in detail in section 5.1.4.4. To provide a visual representation of the project schedule, a Gantt chart has been created. This chart illustrates the timing of various milestones associated with each work package, with assorted colors assigned to differentiate between the work packages.

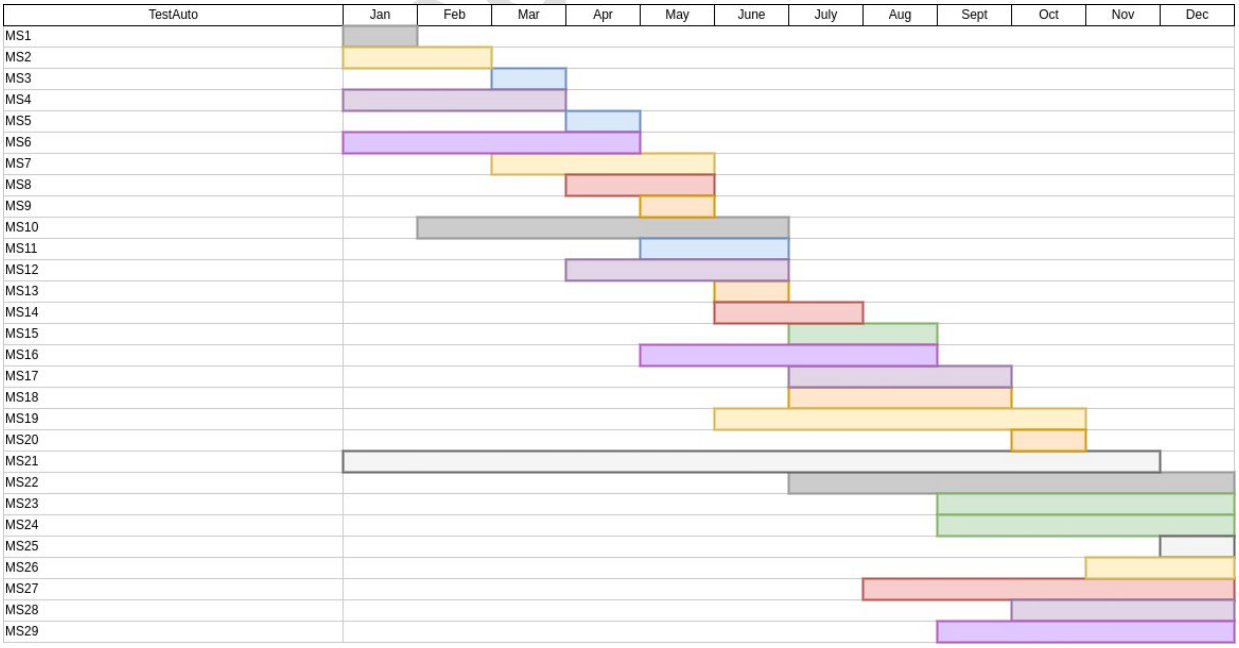
By referring to the Gantt chart, can be easily understandable the chronological order of the milestones and the overall project timeline. The chart serves as a valuable tool for project management, allowing for effective monitoring of progress and ensuring that activities within each work package are appropriately synchronized.

Significant critical points can be observed within the workflow, with the most notable one occurring at the end of the sixth month. The milestones for the work packages have been strategically planned continuously, meaning each milestone depends on the successful completion of the preceding one. This sequential dependency ensures a cohesive and interconnected workflow, where the accomplishment of one milestone paves the way for the next.

5.1.4.3 Risks and associated contingency plans

While most tasks across different work packages can be executed in parallel, certain tasks pose inherent risks and necessitate specific dependencies. For example, the intermediate results of Work Package 2 (WP2) are crucial prerequisites for both Work Package 4 (WP4) and Work Package 3 (WP3). Similarly, the results of WP4 are required for WP3. Additionally, the completion of Work Package 6 (WP6) is essential before initiating Work Package 7 (WP7). Moreover, for the demonstrations outlined in Work Package 9 (WP9), the successful outcomes of the implementation work packages (WP4 and WP6) are indispensable. These interdependencies ensure that the project progresses smoothly and that the desired results can be effectively demonstrated.

5.1.4.4 Gantt chart



5.2 Implementation

5.2.1 Management Structure and Procedures

5.2.1.1 Project Coordinator (PC)

It is responsible for organizing meetings with the PMB and for preparing the agenda covered in the meetings. Communicates all information to the Commission. Receive the entire financial contribution from the Commission. Address the Project Deliverables to the Commission.

5.2.1.2 Project Manager (PM)

Manages the administrative, legal, financial, and other non-technical aspects of the Project. Assists the Project Management Board in the steering of the Project (follow-up of planning schedule, issue reminders for task initiation or completion, etc.). Prepares for the Project Management Board the Project Deliverables based on the reports, the supporting documents and audit certificate to be provided to the Management team by the Beneficiaries.

5.2.1.3 Project Management Board (PMB)

The PMB is responsible for assisting and advising the PC and PM in the overall project administrative management and for representing the interests of each beneficiary in the project. It is composed of the PC and PM. The PMB will meet frequently by internet phone calls or face-to-face meetings to discuss with the PC the status of the project and decide on any corrective or planning actions required for keeping the project focused on the overall vision and mission and deal with any conflicts or risks.

5.2.1.4 Work Package Coordinators (WPC)

The work package coordinators are responsible for ensuring a smooth flow of work within the various sub-components included in their respective work packages and, with the help of the PC and PM, are expected to communicate the relevant results, data, and methodologies across work packages. The work package coordinators are to take part in the decisions of top-level project management through their participation in the Project Management Board.

5.2.1.5 Scientific Project Manager (SPM)

Is responsible for the day-to-day operations, facilitating the communication and integration between science components and activities, and support the project bodies. Is responsible for collating and editing the periodic scientific reports and facilitating synthesis and integration activities across the consortium.

5.2.2 Beneficiaries, Consortium as a Whole

Eötvös Loránd University (ELTE) has a powerful reputation in computer science and related fields. The university offers programs and courses focused on software testing, web development, and artificial intelligence. Through its research and academic activities, ELTE contributes to the advancement of knowledge and expertise in these areas. ELTE is going to oversee the Project Management, such as coordination, writing reporting to the Commission, management of the budget, checking activity and results, managing IP (Intellectual Properties), and holding meetings. It is also going to plan and executes the training and dissemination.

Principal Investigators at ELTE:

- Dr. Tibor Gregorics

The University of Pisa has a distinguished history and reputation in scientific research and education. The university offers programs in computer science and engineering, where students can specialize in areas such as software testing, web development, and AI. Through its research initiatives, the University of Pisa contributes to advancements in testing methodologies, web technologies, and AI algorithms. Students and researchers at the university benefit from a supportive academic environment and opportunities to collaborate with industry partners on projects related to testing, web development, and AI. UNIPI is going to be charge of doing research on how it is the best to weight the properties of GUI elements to locate them more likely when they are changed

through the development process, and implementing a tool, which can generate robust test scripts form manual testing.

Principal Investigators at UNIPI:

- Dr. Roberto Trasarti
- Dr. Franco Turini
- Laura State

The Technical University of Munich (TUM) is a prestigious institution recognized for its excellence in engineering and technology. With a strong focus on research and innovation, TUM offers programs in computer science and related fields. The university has expertise in software testing, web development, and AI, and actively conducts research in these areas. Through its collaborations with industry partners and participation in research projects, TUM contributes to advancements in testing techniques, web technologies, and AI applications. TUM's responsibility is going to be the implementation of a tool, which can generate scripts to test the functionalities of the application based on the UI only.

Principal Investigators at TUM:

- Dr. Andrea Stocco
- Daniel Elsner
- Claudius Jordan
- Prof. Dr. Alexander Pretschner

Brainhub specializes in web and mobile application development and offers expertise in software testing. With a team of experienced professionals, Brainhub provides testing services to ensure the quality and reliability of web applications. The company leverages its expertise in web development to understand the complexities and challenges of testing in this domain. They will carry out the testing of the results of UNIPI's new study on the best way to weight the properties of web elements.

Dinarys Industry specializes in e-commerce solutions and offers a range of services, including web development, and testing. The company specializes in creating robust and visually appealing web applications that cater to the unique requirements of online businesses. Dinarys takes a comprehensive approach to web development, ensuring that websites are not only visually appealing but also highly functional and user-friendly. They have a team of skilled web developers who are experienced in working with various technologies and frameworks. The company's experience in web development provides a solid foundation for testing activities. They will be responsible for testing the new test script generating tools, both the one made by UNIPI and TUM.

5.2.3 Resources to be committed

ELTE:

- Personnel cost: The significant allocation for personnel costs indicates the involvement of a skilled team from ELTE, contributing 38 person-months to the project. This cost covers the salaries and benefits of the team members, reflecting their expertise and dedicated effort.
- Travel: The allocation for travel expenses demonstrates the necessity for ELTE team members to attend project meetings, conferences, or workshops. It allows for collaboration, knowledge sharing, and dissemination of project outcomes.
- Equipment: The modest equipment cost suggests that ELTE requires minimal additional resources specific to this project. It could be for software licenses, testing tools, or other necessary resources.
- Indirect costs: The allocation for indirect costs represents the overhead expenses associated with running the project at ELTE, such as administrative support, facilities, utilities, and other operational expenses.

UNIPI:

- Personnel cost: UNIPI's higher personnel cost allocation reflects their significant contribution of 40 person-months to the project. It indicates the involvement of a skilled team and emphasizes the importance of their expertise in achieving project objectives.
- Travel: The allocation for travel expenses suggests the necessity for UNIPI team members to engage in project-related activities outside their institution. It allows for collaboration, networking, and dissemination of research findings.
- Equipment: The minimal equipment cost signifies that UNIPI's existing infrastructure is sufficient to carry out the project activities without substantial additional investments in equipment.
- Indirect costs: The allocation for indirect costs covers UNIPI's overhead expenses related to project administration, management, and operational support.

TUM:

- Personnel cost: The higher allocation for personnel cost indicates TUM's substantial contribution of 48 person-months to the project. It reflects the involvement of a skilled team and the associated costs of their expertise and dedicated effort.
- Travel: The allocation for travel expenses suggests that TUM team members will engage in project-related travel, such as attending conferences, workshops, or meetings. It allows for knowledge exchange, collaboration, and dissemination of project outcomes.
- Equipment: The nominal equipment cost indicates that TUM's existing infrastructure meets the project requirements, minimizing the need for additional investments in equipment.
- Indirect costs: The allocation for indirect costs covers TUM's overhead expenses related to project management, administration, and operational support.

BRAINHUB:

- Personnel cost: The personnel cost allocation corresponds to the contribution of 12 person-months by BRAINHUB. It reflects the involvement of a smaller team, contributing specialized knowledge and effort to the project.
- Travel: The absence of travel expenses suggests that BRAINHUB's contribution can be effectively fulfilled without the need for project-related travel.
- Equipment: The minimal equipment cost indicates BRAINHUB's limited need for additional resources specific to this project.
- Indirect costs: The allocation for indirect costs covers BRAINHUB's overhead expenses associated with project administration, management, and operational support.

DINARYS:

- Personnel cost: The personnel cost allocation corresponds to the contribution of 27 person-months by DINARYS. It reflects the involvement of a dedicated team, contributing their expertise and effort to the project.
- Travel: The absence of travel expenses suggests that DINARYS' contribution can be effectively fulfilled without the need for project-related travel.
- Equipment: The minimal equipment cost indicates that DINARYS already possesses the necessary resources to carry out the project activities without significant additional investments.
- Indirect costs: The allocation for indirect costs covers DINARYS' overhead expenses related to project administration, management, and operational support.

The budget allocation for each institution is based on several factors, including the estimated effort required, personnel costs, travel needs, equipment requirements, and indirect costs. The allocation of personnel costs primarily accounts for the involvement of skilled professionals contributing their expertise to the project. Travel expenses are allocated based on the necessity for project-related travel, such as attending conferences or meetings. Equipment costs are minimal, indicating that the project can leverage existing resources. Indirect costs cover the administrative and operational expenses associated with running the project at each institution.

5.3 Impact

5.3.1 Strategic Impact

A test script generating tool can automate the process of creating test scripts, saving time and effort for software testers for whole software developing organizations. This increased efficiency allows for faster, and cheaper development cycles and quicker time-to-market for software products.

By automating the generation of test scripts, the tool can ensure consistent and thorough testing of software applications. This leads to improved quality assurance and helps identify bugs and issues early in the development process, reducing the risk of releasing faulty software. The tool improves test coverage and helps identify potential issues that may not have been addressed through manual testing alone. It can also eliminate human errors that can occur during manual script creation.

So overall, the availability of a test script generating tool in Europe can streamline the testing process, improve software quality, reduce costs, and accelerate software development cycles. It can contribute to the growth and advancement of the IT industry in Europe.

It is going to have a positive impact on society, including companies, and entire economic areas by ensuring the delivery of affordable, reliable, and high-quality software applications.

Since other sections use information technology more frequently in their everyday production, the development of the IT section will affect others too. Europe's industry will be at an advantage over America and Asia – the two economically most advanced continents.

5.3.2 Plans for the Use and Dissemination of Foreground Knowledge

We cannot give exact information on the dissemination strategies since it should be investigated through the project. First, we would like to identify target audiences, including researchers, practitioners, software development teams, and decision-makers. Then, determine the best channels and communication strategies to effectively convey the value and benefits of the test script generating tool to each audience. Many different channels are going to be used, e.g.: webinars, workshops, conferences, journals, online platforms such as social media to communicate the scientific aspects, research findings, and practical applications of our tool.

During our project, some research papers in academic conferences and journals related to software testing, AI, and automation will be created. More specifically the topics are going to be:

- "Robust test script generation from manual testing"
- "The improved FTPK tool; correcting broken GUI test scripts"
- "Difficulties of test script generation"
- "AI in test script generation"
- "Generating test scripts based on only the UI"

We also plan to publish technical articles and case studies in industry publications and magazines. Whitepapers and technical documentation outlining the capabilities and benefits of the test script generating tool are also going to be made.

We want to develop a comprehensive business plan that outlines the market analysis, target customers, pricing strategies, distribution channels, and financial projections for the tool. It is a complete innovation, so there are not any competitors in this field yet, and we cannot learn from their weaknesses.

We are going to clearly define ownership and rights for the background knowledge (existing intellectual property) used in developing the test script generating tool. Established agreements will be settled with the relevant parties involved. We will identify potential new intellectual property that may arise from the development and innovation of the test script generating tool, such as novel algorithms, methodologies, or software modules. The cases are going to be:

- Result of UNIPI's study on web element property weighting: It is a creative and innovative work; original research finding. Protecting these results as IP can provide a competitive advantage and prevent unauthorized use or replication and can safeguard the innovation and competence invested in the finding.
- Test Script Generation Algorithm: The core algorithm used in the tool to automatically generate test scripts. This algorithm may involve innovative approaches, techniques, or heuristics that enable efficient and effective generation of test scripts. Protecting this algorithm as IP can provide a competitive advantage and prevent unauthorized use or replication.
- User Interface Design: The design of the tool's user interface (UI). A well-designed UI that enhances the usability and intuitiveness of the tool can contribute to its success and differentiate it from competing solutions. Protecting the UI design can help maintain exclusivity and prevent unauthorized replication.
- Integration Techniques: If the test script generating tool integrates with other software tools, frameworks, or platforms, then the methods and techniques used for seamless integration is IP. This may involve innovative approaches to connect with different testing frameworks, version control systems, or development environments. Protecting these integration techniques can provide a competitive edge and maintain uniqueness in the market.
- Machine Learning Models: These models may learn from existing test cases, historical data, or user feedback to enhance test script generation accuracy, adaptability, or efficiency. Protecting these machine learning models can safeguard the innovation and expertise invested in their development.

We are going to develop strategies for legal protection of foreground IPs (Intellectual Properties), including considerations for patent applications, copyrights, trademarks, or trade secrets. Consultation with legal experts to ensure appropriate steps are taken for IP protection will be necessary.