End-to-End Testing Gamification: A Novel Approach to the Verification and Validation of Web and Mobile Applications

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Abstract

Software testing is one of the most important phases of the software development process, since it allows to assess and improve the quality of the software product. One of the most common testing approaches is End-to-End testing, which consists of validating the entire application under test as a whole, not focusing on the individual components, but on the higher-level workflow. This kind of testing gives high confidence in meeting business requirements. However, End-to-End testing typically requires human intervention, which makes it a slow and expensive technique. At the same time, several studies suggest that software testing is often perceived as a tedious activity by human beings. A potential solution to this problem is gamification, i.e. the application of game design mechanics to non-ludic activities, to increase the motivation of the subjects involved. In recent years, gamification has become increasingly popular in the software engineering field, being applied to development, design, and testing. My Ph.D. path explores the possibilities given by the application of gamification to End-to-End software testing, with a focus on mobile and web applications. The goal is to realize, assess and evaluate software systems that integrate the classic End-to-end testing techniques, such as exploratory testing, with gamification aspects, such as leaderboards, competition, and levels.

CCS Concepts

• **Software and its engineering → Software testing and debugging**.

Keywords

Gamification, Software, Testing, Mobile, Web, End-to-End, Validation

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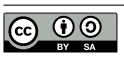

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1 Introduction

Software testing is a critical part of the software development process. Good testing aims at limiting the presence of bugs thus guaranteeing the overall quality of the software product. One of the most widely used approaches to software testing is End-to-End (E2E) Software Testing, which consists of validating the Application Under Test (AUT) workflow from start to finish, in a real-world scenario, adopting the users' point of view. In practice, this translates into the validation of user scenarios. Because of this close relationship with end users, E2E typically results in techniques that are difficult to automate, thus requiring human intervention. This makes E2E testing a rather slow and expensive technique. Moreover, in the context of E2E testing, the repetitiveness of many testing scenarios exacerbates the already existing perception of testing as a boring activity [16]. A possible solution to this problem is represented by gamification. Gamification refers to the application of game-design principles and elements in non-ludic contexts to engage and motivate subjects [6]. In recent years, gamification has gained increasing popularity in software engineering as a strategy to enhance productivity, engagement, and collaboration across various activities [1]. In particular, there has been an increasing interest in using gamification in software testing, with positive outcomes [10]. The incorporation of game-like elements into software development processes addresses some of the field's inherent challenges, such as repetitive tasks, lack of immediate feedback, and the difficulty of maintaining motivation in team-based environments.

2 Background and Related Work

The problem of increasing testers' performances and engagement through gamification has been addressed by several studies. From an analysis of the results obtained in the literature, we can derive some considerations. First, some experimental results have shown a positive impact of gamification on the engagement and enjoyment of testers [8] [2] [15] [17]. In line with results from other fields, gamified approaches have been found useful for the learning experience [7] and funnier than the non-gamified ones [11]. The potential influence on motivation needs to be studied more in-depth: some researchers have reported an increased level of motivation with gamified approaches [18] while others have measured a higher level of motivation with standard approaches [11]. When applied to exploratory GUI testing, gamification has led to an increase in efficiency, but no significant impact on the efficacy of the testing process was detected [5] [9]. Finally, gamification seems to be positively related to software quality in the long term [15].

These findings are sufficient to motivate more in-depth research work aimed at studying the relationship between gamification and software quality assurance.

3 Research Questions and Methodology

The Research Questions (RQs) that guide the PhD project can be summarized as follows:

RQ1: Are there any benefits in the application of gamification techniques to End-to-End (E2E) software testing?
More specifically:
- RQ1.1: Can the gamification of E2E software testing improve the efficacy of software testers?
- RQ1.2: Can the gamification of E2E software testing improve the efficiency of software testers?
- RQ1.3: Can the gamification of E2E software testing increase the engagement level of software testers?

RQ2: What are the most suitable E2E software testing techniques that can benefit from a gamified approach?

To answer these questions, we propose an approach based on the following steps:

Problem analysis: A detailed and sound analysis of the existing literature on gamified End-to-End testing, including a comparison of the methodologies applied and the results obtained, with the goal of identifying the best strategy to approach the RQs and the unexplored areas.

Tool design and implementation: Design and implementation of a tool for the application of gamification mechanics to End-to-End testing. The design should take into account the existing frameworks for the gamification of tasks, such as the Octalysis Framework [4].

Experimental evaluation: Evaluation of the tool in an experimental setting, with students and/or practitioners, adopting the Goal Question Metric approach (GQM) [3] and possibly leveraging existing frameworks if applicable.

4 Preliminary Results and Future Work

Our work to date focused mainly on E2E Exploratory GUI testing. We developed two tools for gamified Exploratory GUI testing:

ScoutDroid: A plugin that introduces mobile Augmented Testing (AT) [14] into an already existing platform for web applications exploratory GUI testing [13]. AT is a technique that guides the testers during the testing session by displaying graphical aids on top of the GUI being tested.

GAppium Inspector: A stand-alone application built on top of the existing Appium Inspector tool which introduces some gamification elements, like progress bars and avatars [12].

Future work includes the possibility of improving the proposed tools by introducing other gamification mechanics, and evaluating such tools in an experimental context *in vivo* with practitioners from the industry.

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