Abstract: In-Time Testing of Evolving Systems with Long-Standing Mutants

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I. Reference

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II. Introduction

Software systems often evolve through a significant number of modifications and increments. Applying continuous testing of evolving systems requires significant effort to re-assess changed program functionality. Often evolution cycles apply automated testing enabling later test reuse. Although often practical and helpful, this practice leaves the question of test adequacy open as tests adequate for one version are not necessarily adequate for evolved versions.

Mutation testing, the most effective software testing technique, deals with the question of adequacy. It operates by seeding artificial faults, aka mutants, and checking the ability of testing to reveal them. The technique is proven effective, but its broad application is impractical for evolving systems due to the generation and analysis of a large number of mutants. To deal with the problem, researchers have proposed mutant selection to reduce the burden of numerous mutant candidates by performing expensive analyses on a given program version with the hope that it will produce tests which will return investments in future versions. More recently, commit-aware mutation testing has been proposed to avoid test degradation. The technique aims to guide test augmentation by aiming at the changed program functionality. The analysis of commit-aware mutants can assess behaviours impacted by unforeseen interactions of changed and not-changed parts of the code. While this state-of-the-art technique covers the aspect of testing the changed program functionality, it leaves out the adequacy of the given program version as a whole. It currently still performs mutation analysis in commit2commit practice, potentially being a yet costly strategy for broader industrial applications.

To this end, our study investigates whether the knowledge from reappearing mutants should be utilized over consecutive versions as the code core logic change less drastically once it reaches maturity. We investigate the existence of mutants that can provide accurate test assessment for extended periods (a considerable number of program versions). We call this new category of mutants long-standing. Further, we examine the extend to which mutant selection can provide accurate test assessment over different sequential program versions.

Our results reveal the scope of the occurrence of the long-standing mutant and show the existence of a minimal (read subsuming) set of long-standing optimal mutants suitable to convey knowledge of mutant's dynamic relationships through time. Our initial findings suggest that mutants have a diverse lifetime over projects' evolution timelines. Selecting an optimal set of subsuming long-standing mutants can provide benefits for around 10x amount of times longer than random selection. Indicating and demonstrating how mutant selection can affect the test assessment capability of mutation testing over time.

We envision devising a technique that selects mutants that are not only strong but also provide accurate test assessments over a more extended period of time. We show that many mutants generated on one version will become obsolete or offer poor assessment in future versions. Therefore, it is vital to select long-standing mutants that can maximize the investment return at a given time. Our scientific intuition says that long-standing mutants would play a significant role in satisfying pending test requirements and covering technical testing debts resulting ultimately in test completeness. Altogether, our study casts new insights on mutation testing for evolving systems, opening a new research direction: long-standing mutants suitable to convey knowledge over time.

III. Contribution

- The definition of the notion of long-standing mutants that can provide test assessment for a long duration of time.
- Demonstrate how the mutants have a diverse lifetime over projects' evolution timelines.
- Demonstration of how mutant selection can affect the test assessment capability of mutation testing over time.

IV. Talk outline

The talk outline will be the following:

- Introducing definition of long-standing mutants and their relation with in-time testing of evolving systems.
- Initial results on the lifetime of long-standing mutants over projects' evolution timeline.
- Early findings and scientific intuitions on capabilities of long-standing mutants and how they can affect the test assessment over time.