Doctoral Program in Computer and Control Engineering (30th cycle)

Doctoral Dissertation

Evolution and Fragility of MobileAutomated Test Suites

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Android applications have reached a level of diffusion and complexity that was once exclusive of desktop computing, hence demanding a thorough validation and verification phase to ensure that they meet their requirements. Such need especially applies to their GUIs (i.e., Graphical User Interfaces) through which most of the interaction with the final user is performed. However, although many approaches, techniques and tools exist to test Android apps, evidence from the literature suggests that GUI testing is generally limited among practitioners.

The main goals of the studies reported in this thesis have been: (i) assess the usability of existing GUI testing techniques applicable to Android apps; (ii) quantify the adoption of existing tools by developers from the open-source environment; (iii) investigate the amount of effort needed in maintaining test suites during their coevolution with the AUT (Application Under Test) and the principal reasons behind the interventions; (iv) identify the main issues faced by Android testers, and provide guidelines and tools to aid reducing their impact on testing design and maintenance.

These goals were pursued by performing five different studies, after a preliminary exploratory study on a popular open-source app. An experiment with Graduate students and a survey with developers from the industry were conducted in order to gather qualitative information about the usability of testing tools and techniques, and to understand what are the needs and difficulties felt by different categories of users of those tools. Starting from a mining of all tested Android applications published on GitHub, a set of metrics for quantifying testware evolution and maintenance and a taxonomy of maintenance reasons were defined and validated. Finally, a tool that leverages the benefits of two GUI testing techniques (Layout-based and Visual) was implemented and validated.

The studies showed that the diffusion of testing tools is limited on the set of projects mined from GitHub, the largest context for this kind of quantitative experiments up to date. It is deduced that GUI testing frameworks are characterized by a steep learning curve and are often considered imprecise by developers. Additionally, test suites suffer from many types of fragility, requiring a relevant maintenance effort (estimated as 5% of total development effort). To mitigate the fragility issues, the TOGGLE tool has been developed. The implemented translational approach proved to be able to relieve the testers from part of the effort in maintaining test suites, and mitigate the drawbacks of the two approaches that were considered in the studies.

In summary, Automated GUI testing frameworks for Android are still far from being widely adopted by either open-source or industry developers, and a relevant reason for this missing diffusion is their fragility to the evolution of the tested AUT. The results of the study gathered in this thesis suggest that there is still room for improvement of existing testing techniques to mitigate their current drawbacks. The proposed translational approach can serve as a first effort in reducing the complexities of co-evolving mobile apps along with their testware.