

Bachelor Thesis

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GUI usability and testing of mobile applications

Example subtitle

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“Program testing can be used to show the presence of bugs, but never to show their absence.”
Edsger W. Dijkstra

Acknowledgements

Abstract

Zusammenfassung

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Introduction

1.1 Context

1.2 Motivation

1.3 Motivation Example

1.4 Research question

Subsubsection



Figure 1.1: imgs/seal logo

1.4.1 Subsection

Paragraph. Always with a point.

```
/**
 * Javadoc comment
 */
public class Foo {
    // line comment
    public void bar(int number) {
```

```
    if (number < 0) {  
        return; /* block comment */  
    }  
}
```

Listing 1.1: An example code snippet

Related Work

In the following two sections, I summarize the main related works on *automated testing tools for Android apps* and on *the broadly usage of user reviews from app store in Software maintenance activities*. An overview of the recent research in the field can be found in the survey by Martin *et al.* [12].

2.1 Automated tools for Android Testing

Unlike traditional software, mobile applications are mainly exercised by user inputs.

In the mobile world, an extremely valid approach to ensure the reliability of these applications is the GUI¹ Testing.

In particular, in this kind of testing, each test case is designed and run in the form of sequences of GUI interaction events.

Depending on their exploration strategy, there are in general three approaches for creating a generation of user inputs on a mobile device [5, 9]: *random testing* [6, 9], *systematic testing* [10] and *model-based testing* [2, 3, 8].

Fuzz testing

Monkey, is the most widely used tool in practice for testing Android applications with a random strategy [6]. It is the official Android testing command-line tool directly provided by Google.

This tool simply generates, for the specified Android applications, pseudo-random streams of user events into the system, with the goal to stress the AUT² [6].

The effort required for using *Monkey* is very low [5]. Users have to specify in the command-line the type and the number of the UI events they want to generate and in addition they can establish the verbosity level of the *Monkey log*.

The set of possible *Monkey parameters* can be found in the official *User Guide* for *Monkey* [6].

The kind of testing implemented by *Monkey* follows a black-box approach. Despite the robustness, the user friendliness [5, 9] and the capacity to find out new bugs outside the stated scenarios [1], this tool may be inefficient if the AUT would require some human intelligence (*e.g.* a login field) for providing sensible inputs [9].

For this reason, *Monkey* may cause highly redundant and senseless user events. Even though it would find out a new bug for a given app, the steps for reproducing it may be very difficult to follow, due also to the randomness in the testing strategy implemented by *Monkey* [1].

Dynodroid [9] is also a random-based testing approach. However, this tool has been discovered

¹Graphical User Interface

²Application Under Test

being more efficient than *Monkey* in the exploration process [5].

One of the reasons behind a better efficacy has been that *Dynodroid* is able to generate both *UI inputs* and *system events* (unlike *Monkey*, which can only generate UI events) [5].

Indeed, *Dynodroid* can simulate an incoming SMS message on a mobile device, a notification of another app or an request of use for available wifi networks in the neighborhood [9]. All these events represent *non-UI events* and they are often unpredictable and therefore difficult to simulate in a suitable context (cita?).

Dynodroid views the *AUT* as an event-driven program and follows a cyclical mechanism, also known as the *observe-select-execute* cycle [9]. First of all, it *observes* which events are relevant to the *AUT* in the current state, grouping them together (an event must be considered relevant if it triggers a part of code which is part of the *AUT*). After that, it *selects* one of the previously observed events with a randomized algorithm [5,9] and finally *executes* it. After the execution of that event it reaches a new state and can start the cycle again.

Another advantage of *Dynodroid* compared to *Monkey* is that it allows users to interact in the testing process providing UI inputs. In doing so, *Dynodroid* is able to exploit the benefits of combining automated with manual testing [9].

Systematic testing

The tools using a systematic explorations strategy rely on more sophisticated techniques, such as symbolic execution and evolutionary algorithms [5].

Sapienz [11] introduced a Pareto multi-objective search-based technique to simultaneously maximize coverage and fault revelation, while minimizing the sequence lengths.

It combines the above mentioned random-based approach with a new systematic exploration and as mentioned in the experimental results published on [11], *Sapienz* is an outperformer in the automated mobile testing area.

Indeed, in an empirical study described on [11], *Sapienz* has illustrated the strength of its approach. It found from a set of 68 benchmark apps, 104 unique crashes (while *Monkey* 41 and *Dynodroid* 13).

Model-based testing

Model-based tools for testing Android applications are quite popular [11]. Most of these tools [2–4, 8, 14] generate UI events from models, which are either manually designed or created from XML configuration files [11].

For example, *SwiftHand*³ uses a machine learning algorithm to learn a model of the current *AUT*. This final state machine model [5] generates UI events and due their execution the app reaches new unexplored states. After that, it exploits the execution of these events to adapt and refine the model [4]. *SwiftHand*, in a similar way to *Monkey* generates only touching and scrolling UI events and is not able to generate System events [5].

2.2 Usage of users reviews in Software maintenance activities

The concept of app store mining was first introduced by *Harman et al.* [7]. In this context, many researchers focused on the analysis of user reviews to support the maintenance and evolution of mobile applications [13].

³<https://github.com/wtchoi/SwiftHand>

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