Survey Instructions

1. Introduction

Thank you for participating in this study. The goal of this study is to determine the accuracy of a software tool (called EULER) at assessing the quality of the steps to reproduce described in a bug report.

You will answer a questionnaire for a set of bug reports from several Android applications. Before answering the survey, make sure you carefully read all the instructions in this document.

2. Definitions

Bug report: A textual document that describes a software bug. The main purpose of bug reports is to collect information relevant to software developers for correcting the bug in the software. While there are several types of bug reports, in this study, we will consider bug reports manually written by software end-users.

Typically, bug reports have the following parts:
- Bug summary: a sentence that summarizes the reported bug
- Bug description: a detailed account of the software bug
- Bug metadata: a set of attributes of the software bug, for example, bug severity, application version, device model, etc.

Also, within the bug summary and description, users describe the following three main information types:
- Observed behavior: a description of the incorrect or unexpected application behavior
- Expected behavior: the normal/correct application behavior
- Steps to Reproduce: the sequence of interactions to reproduce the observed behavior in the application (more details below)

Steps to Reproduce (S2R): The sequence of interactions that the user performed on the mobile device or application for producing the incorrect or unexpected application behavior. These interactions can be described in the bug report in the form of bullet lists and imperative sentences (e.g., "open the application") as well as in any other form of natural language description (e.g., in narrative form: "When I was opening the application…). The following are some S2R examples:
- Tap the menu button
- Create an event in the calendar
- Navigate to the report screen

- When I scrolled down the menu the application crashed
- After I long tapped the button a popup incorrectly opened
- I replicate the problem by opening the date picker

GUI component: A graphical element of an application screen.

Common GUI components in Android applications are:
- Buttons
  - FAB (Floating Action Button): a circular button that triggers the primary action in an app
- Text fields (aka. Edit Texts)
- Labels (aka Text Views)
- Views (i.e., a rectangle box)
- List views (i.e., a rectangle box that displays a list of scrollable items)
- Image buttons
- Dropdown lists (aka. Spinners)
- Checkboxes
- Toggle buttons, Radio buttons, Progress bars, time pickers, Date pickers, etc.

App interaction: An action performed by the user for interacting with a mobile device or application.

Common actions are "tap/click", "long tap/click", "swipe up/down/right/left", and "type" (e.g., "type a $10 in the price field"). These actions can be described using synonyms, e.g., scroll or drag for "swipes". The action can be applied to specific GUI components (e.g., "tap on a button X" or "swipe down the menu options") in different parts of the screen.

Typically, an app interaction is the combination of an action and a GUI component (as seen in the examples above).

3. Android Applications

In this study, we use bug reports from the following Android applications. Please take a moment to open the Play Store web page of each application to learn more about it (e.g., open the screenshots shown on the web page).

Application Name	App Description	Application category	Play store URL
Aard Dictionary	Dictionary and Wikipedia reader	Books and Reference	https://play.google.com/store/apps/details?id=aarddict.android
Droid Weight	Body weight tracker	Health & Fitness	https://play.google.com/store/apps/details?id=de.delusions.measure
GnuCash	Finance expense manager	Finance	https://play.google.com/store/apps/details?id=org.gnucash.android
Mileage	Car mileage tracker	Finance	https://play.google.com/store/apps/details?id=com.evancharlton.mileage
Schedule	Conference scheduler	Books and Reference	https://play.google.com/store/apps/details?id=nerd.tuxmobil.fahrplan.congress
A Time Tracker	Time tracker	Productivity	https://play.google.com/store/apps/details?id=com.markuspage.android.atimetracker

4. The EULER tool

EULER is a software tool that automatically identifies the steps to reproduce described in a bug report and provides automatic feedback to the users about the quality of such steps. **When the user is writing a bug report or after she submits the report, the tool gives feedback to the user about problems in the S2R. The user, based on the provided feedback, fixes the problems and writes the S2R better.** The current version of EULER analyzes bug reports of open-source Android mobile applications.

4.1. EULER's Quality Report

EULER generates an HTML-based Quality Report for a bug report. An example of a quality report is shown in the next Figure.

You can also access the quality report from the previous Figure by following this link.

The Quality Report has two parts:

1. The first part shows information about the analyzed bug report (i.e., application and its version, bug report id, bug summary, and bug description)
2. The second part shows the quality assessment for each identified step to reproduce from the bug report. The quality assessment is one or more Quality Annotations. For each annotation, EULER shows an icon that indicates the Annotation Type, a natural language statement that describes the annotation, and additional details.
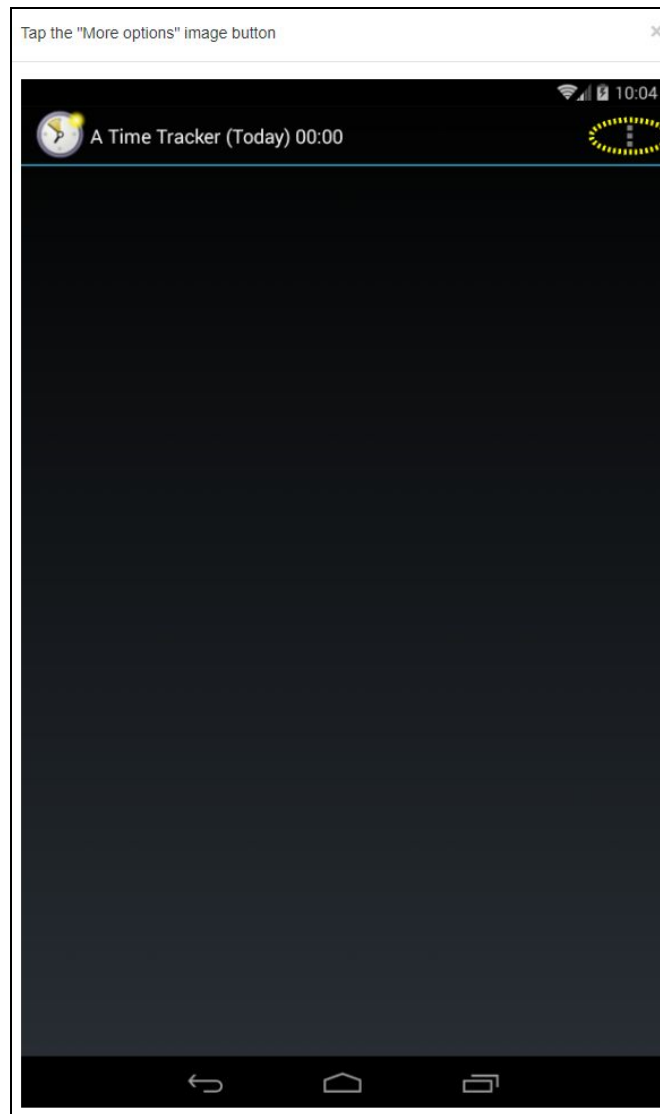
4.2. EULER's Quality Annotations

EULER produces one or more of the following annotations for each step to reproduce (S2R) identified from the bug report:

Exact Match (EM): this annotation indicates that the S2R can be precisely matched to an app interaction (e.g., "tap on the OK button"). In other words, the S2R corresponds to a specific interaction in the application or mobile device. The next Figure shows an example of this annotation.

#	Identified Step to Reproduce (S2R)	Quality Annotations for the S2R
2	Click on "..." (More Options...)	EM This S2R matches the following app interaction: 1. Tap the "More options" image button

For this annotation, EULER shows the matched app interaction for the S2R. In the Quality Report, the app interaction is highlighted in blue and can be clicked to open a pop-up window that shows a screen capture of the application as well as the GUI component affected by the interaction (highlighted with a yellow oval - see the next Figures). This can be seen in the following Figure.

Ambiguous Step (AS): this annotation indicates that the S2R can be matched to more than one action or GUI component of the app (e.g., "tap on a web link" for screens where there are many web links, or "change the value" where "change" could mean one or more actions: tap, long-tap, or swipe). The next Figure shows an example of this annotation.

#	Identified Step to Reproduce (S2R)	Quality Annotations for the S2R
1	Enter fillup data	**AS** This S2R matches multiple GUI components (e.g., the "text 1 (Extra data)" text view or the "text 1 (Fillup information)" text view).

Vocabulary Mismatch (VM): this annotation indicates that vocabulary of the S2R does not match the vocabulary of the application (e.g., "tap on element" for applications where the term "element" is not used in any of its screens). The next Figure shows an example of this annotation.

#	Identified Step to Reproduce (S2R)	Quality Annotations for the S2R
6	Long click on Element	**VM** The term "on Element" does not match a GUI component from the app.

Incorrect Input Value (IV): this annotation is for steps that are about typing or entering an input value into the application (e.g., "enter the task name"). The annotation indicates the S2R does not provide a specific input value (e.g, "enter the price of an item" instead of "enter $10 as the price of an item). The next Figure shows an example of this annotation.

#	Identified Step to Reproduce (S2R)	Quality Annotations for the S2R
1	Enter price per km	**IV** This S2R's input value is missing or incorrect. An example of a valid value is: 5

Missing Steps (MS): this annotation indicates that before executing this S2R in the application there are other app interactions (or steps) that should be executed before the current S2R for reproducing the bug.

For example, suppose that the only S2R present in a bug report is "tap on menu option X". Suppose that this action requires that the menu Y is opened first, i.e., the menu where the menu option X is located. In this case, "open menu Y" is a missing step (or interaction) because it is not described in the bug report and should be executed before "tap on menu option X". The next Figure shows an example of this annotation.

#	Identified Step to Reproduce (S2R)	Quality Annotations for the S2R
2	Long click on item	**MS** There are app interactions that are missing in the bug report and should be executed before this S2R: 1. Tap the image button 2. Tap the drop down list 3. Tap the list view

As seen in the figure, EULER shows the list of missing steps (highlighted in blue). Like for the EM cases, each missing step or app interaction can be clicked to display a screenshot showing the interaction.

5. Answering the survey

You will be provided with web links for a set of bug reports. The links will take you to an individual survey for each bug report. Click each link for opening each survey. The instructions below are for completing each survey.

For each bug report (i.e., in each individual survey), you will be provided with a link that opens a web page. The web page has three parts:
1. The original bug report
2. A (YouTube) video showing how to reproduce the bug described in the bug report
3. A transcript of application interactions shown in the video

Complete the following steps:
1. Open the web page described above.
2. Read an understand the bug report (the bug summary and description). Identify the steps to reproduce present in both the bug summary and description.
3. Watch the video and understand the steps or interactions that reproduce the reported bug.
4. Read the video transcript. The transcribed steps will give you more details about each interaction shown in the video. The transcript will also show the steps to reproduce from the bug report and its correspondence to the app interactions shown in the video. **Note that the reproduction scenario shown in the video does not guarantee that the bug will be reproduced**. This is because in some cases, the steps to reproduce the bug, described in the bug report, simply do not replicate the problem.
5. Open the link corresponding to EULER's Quality Report. Read the report and use the background information from the original bug report, video, and the video transcript to guide your understanding of the assessment given in the Quality Report.
6. Based on your understanding of the reproduction scenario shown in the video and in the video transcript, you will be asked to answer a series of questions. While answering these questions, feel free to watch the video again, read the transcript or examine the quality report at any time. In particular, you will be asked the following **three questions** for each S2R that EULER identifies in the original report:

Q1: This question asks whether or not EULER identified correctly the **highlighted sentence** from the original bug report as **a Step to Reproduce (S2R)**. This is a Q1 example:

> The tool identified the highlighted (#2) statement from the **original bug report** as a step to reproduce:
>
> 1. Enter few fillups
> **2. Go to stats**
>
> Was the step to reproduce correctly identified?
>
> Useful links: [Quality Report] [Original bug report and video] [Annotation types]
>
> | Yes | No |
> |-----|-----|

Q2: For each Quality Annotation that EULER assigns to an S2R, you will be asked whether you agree or disagree with the annotation. If you disagree, you will be asked to explain your reasoning. Please be as specific as possible. This is a Q2 example:

> Do you agree with the highlighted quality annotation for the step to reproduce (S2R) #2 (highlighted in boldface)?
>
> | # | Step to Reproduce (S2R) | Quality Annotation |
> |---|-------------------------|--------------------|
> | 1 | Enter few fillups | |
> | **2** | **Go to stats** | **EM** This S2R matches the following app interaction:

 1. Tap the "title (Statistics)" text view |
>
> Exact Match: HQ Ambiguous Step: AS Vocabulary Mismatch: VM Incorrect Input Value: IV Missing Steps: MS
>
> Useful links: [Quality Report] [Original bug report and video] [Annotation types]
>
> | I agree | I disagree |
> |---------|-----------|
>
> If you selected "I disagree", please explain why you disagree with the quality annotation (be specific).
>
> [   ]

Q3: In cases where EULER annotates an S2R with a Missing Steps (MS) annotation, there will be an additional question that will ask you to evaluate the suggested list of missing steps. **You can select one or more of the following evaluation options.**

- **Option 1: The suggested missing steps are correct.**
  - This option should be selected if the options below are <u>FALSE</u>.
- **Option 2: There are extra steps in the suggested missing steps**
  - This option should be selected if the missing steps contain extra steps unnecessary to execute the current S2R.
- **Option 3: There are steps not present in the suggested missing steps**
  - This option should be selected if there are additional steps required to execute the current S2R but are not suggested by the EULER (as missing steps).
- **Option 4: The order of missing steps is incorrect**
  - This option should be selected if any the suggested steps are out of order.

You will be asked to explain your reasoning and details for selecting options 2 through 4. Please be as specific as possible. This is a Q3 example:

Regarding the suggested missing steps (highlighted) select all the statements below that you agree with (multiple choice). Feel free to review the Quality Report to see the screenshot for each missing step.

#	Step to Reproduce (S2R)	List of Missing Steps
1	Enter few fillups	
2	Go to stats	1. Type a valid input (e.g., 1) on the "price (Price per Gallons)" text field 2. Type a valid input (e.g., 2) on the "volume (Gallons)" text field 3. Type a valid input (e.g., 3) on the "odometer (Odometer)" text field 4. Tap the "partial (Tank was not filled to the top)" check box 5. Type a valid input (e.g., 4) on the "Comment" text field 6. Tap the "save btn (Save Fillup)" button

Useful links: [Quality Report] [Original bug report and video] [Annotation types]

The missing steps are correct

There are extra steps in the list of missing steps

There are steps not present in the list of missing steps

The order of the missing steps is incorrect

Please provide details for the selected answers (e.g., provide the extra steps or the additional steps not found in the suggested list, or include the steps in the right order).

7. The last step in the survey is to answer a set of questions related to the usefulness and user experience of reading the Quality Report.