Manual Inspection

I. Ultimate Goal

The goal of manual inspection of bug reports is threefold:

1. to determine the research questions of this study and gain preliminary answers to the research questions from firsthand observations;
2. to summarize the practices that we do not understand and want to inquire the developers when conducting the follow-up survey;
3. to identify the challenges during fixing cross-project bugs which can shed light on the future research.

II. Participants

Three of the authors of the paper.

III. Duration

Apr. 1st, 2016 ~ May. 15th, 2016

IV. Process

The manual inspection took two phases. In either phase, the three authors (that conducted the manual analysis) individually inspected the bug reports and hold meetings to discuss the observations and ideas. In general, the authors followed the same procedure and criteria in determining cross-project bugs, time required to fix bugs, related interactions between developers, and bug resolutions. They also cross-checked each other's results to minimize personal bias. The following part describes the details of the two phases.

A. *Phase 1*

1) *Objectives*

- To select the true cross-project correlated bugs from the 542 pairs of candidates;
- To find out the main differences in the fixing processes between cross-project and within-project bugs, in order to:
  a. identify the challenges that the developers are facing when fixing cross-project bugs;
  b. determine the research questions which we intend to make further investigation.

2) *Studied Bugs*

- **542 pairs of candidate cross-project correlated bugs**: the identification of cross-project correlated bugs is a semi-automatic process. After automatically parsing the issue reports to identify the references between issues of different projects, we totally collected 542 pairs of candidates which needed a further manual confirmation.
- **At least 350 within-project bugs**: each of the three authors randomly and individually selected at least 50 within-project bugs for each of the seven studied projects. Note that the authors did not know each other's list of selected within-project bugs, so the 350+ within-

project bugs inspected by different authors might be duplicate.

3) Procedure

- Individual inspection (Apr. 3rd, 2016 ~ Apr. 22nd, 2016)
  a. Each author individually checked every pair of the candidate correlated bugs to examine whether one issue was caused by the other. If so, the pair of bugs was considered as cross-project correlated bugs. If not, the bugs were discarded from this study;
  b. The authors each read the reports of within-project bugs and observed their fixing process;
  c. The authors each noted down the fixing process of cross-project bugs together with representative examples, as well as compared the differences between fixing cross-project bugs and fixing within-project ones;
  d. They also required to record useful examples or comments which could reveal the challenges during fixing bugs or inspire the future work;
  e. Each bug reports might be reviewed multiple times by an author.
- Meeting (Apr. 23rd, 2016 ~ Apr. 24th, 2016)
  a. The three authors cross-checked each other's results of confirmed cross-project bugs and determined the final results;
  b. They discussed the main differences and summarized the main challenges;
  c. They determined the research focus and specific research questions of this study.

4) Outcome

- Typical fixing processes of cross-project and within-project bugs;
- The list of typical and motivating examples of cross-project bugs;
- The challenges during fixing cross-project bugs which deserves a deep investigation in this study or future studies;
- Research questions which we attempt to answer in this study.

B. Phase 2

1) Objectives

- To track the possible answers to the research questions;
- To summarize the questions that we plan to ask the developers in the survey.

2) Studied Bugs

271 pairs of cross-project correlated bugs

3) Procedure

- Meeting (Apr. 25th, 2016 ~ Apr. 26th, 2016)

  The three authors first got together to discuss what aspects should be taken into account when inspecting the bug reports to seek for the possible answers. Based on the related work, their own experience, and the impressions from the first round inspection, the three authors decided to focus on the following three aspects to extract important factors for tracking root cause.
  - Content of bug reports: the information that the reporter provided to describe the problems they encountered;
  - Social interaction: the relationships between reporters and developers of the involving projects, the communications between developers in different projects, the popularity of

the projects and so on;

> Developers' familiarity with involving projects: the developers' expertise on the reported problems and involving projects.

- Individual inspection (Apr. 27th, 2016 ~ May. 11th, 2016)
  a. For every pair of cross-project bugs, the three author independently read the bug reports and wrote down notes about RQ2 and RQ3 in a pre-defined format;
  b. They were also required to record typical examples and useful comments in the bug reports;
  c. They were encouraged to identify other aspects that were not mentioned in the meeting but found to be useful for tracking the root causes.
  d. Any doubt or question about the developers' practices and comments should be carefully recorded.

- Meeting (May. 12th, 2016 ~ May. 15th, 2016)
  a. The three authors first discussed, classified, and summarized the identified factors (RQ2) and fixing practices (RQ3);
  b. For each pair of cross-project bugs, the authors compare their results in terms of the factors and fixing practices;
  c. For each factor and fixing practice, the authors calculated how many pairs of cross-project bugs involved.
  d. They discussed and decided the questions in the follow-up survey.

4) Outcome

- The preliminary answers to the research questions;
- The draft of the questionnaire.

V.   Limitations

The subjectivity of manual inspection is unavoidable. To reduce it, three of the authors individually inspected the bug reports and summarized their observations. Then they got together to compare, discuss, and integrate the findings and ideas. For each research question, we also have concrete data and instance got from bug reports to make our results reliable. However, it is in general difficult to completely eliminate the influence of researchers' preconceptions. We will discuss it in the threat to validity in the paper.