Generalizability Study

To determine if other software projects follow similar issue resolution patterns to Firefox's, we conducted a small case study that annotated 20 issue reports from two open-source projects: Chromium [152] and GnuCash [153].

Generalizability Study Methodology. We adopted the same methodology that we applied to identify the issue resolution patterns for Firefox on the 10 issues from Chromium [152] and the 10 issues of GnuCash [153].

We selected these two open-source projects as they are different scales and governance structures. Chromium is a large desktop web browser (like Firefox), while GnuCash is a medium-sized desktop application for managing personal finances. Chromium is developed by Google [154], and has a different governance structure than Firefox Firefox[1][2]. Chromium uses google issue tracker [155] as the issue tracking system. On the other hand, GnuCash is developed and maintained by volunteers. It uses Bugzilla [151] as its issue-tracking system.

From each project, we selected 10 issue reports based on the following criteria: (1) the issues were created on 1st January 2020 or later to investigate the recent issue resolution, (2) the issues are FIXED and/or RESOLVED, and (3) the issues cover different # of comments, issue types, and creation years. The issues were selected randomly, selecting one issue at a time until the criteria and target number of issues were met.

We investigated the issue reports including title, description, meta information, attached files, links, *etc.*, annotated developers' conversations, and derived the resolution patterns following the same methodology that we followed for Firefox issues. Finally, we mapped the derived patterns for these 20 issues to a subset of the 47 Firefox patterns based on the similarity of the resolution process the patterns represent.

Results. We identified seven distinct resolution patterns for the 10 issue reports of the Chromium project, all of which correspond to Firefox's patterns. Three patterns, **'I,CR'**, **'I,CR,V'**, and **'SD,I,CR,V'** appeared in two issues each, aligning with Firefox patterns **'I,CR,I?'**, **'I,CR,V,I?'**, and **'SD,I,CR,(I|V)'** which appeared in 64, 16, and 24 issues respectively. Among the three Firefox patterns, the first two have an optional IMPLEMENTATION at the end which means they can be performed if needed, and the third pattern, *i.e.,* **'(I|V)'**, implies that either one of IMPLEMENTATION and VERIFICATION or both can be performed. Notably, these three Firefox patterns are among the top seven most recurrent patterns, which strengthens the generalizability of the Firefox patterns (as they are found in Chromium issues as well).

In the GnuCash project, we identified 10 resolution patterns across the 10 issues, with nine of these patterns aligning with nine of the 47 Firefox patterns. The nine Firefox patterns are fairly common as they were observed in 4 to 22 issues. The only GnuCash pattern, *i.e.,* **'(A,I)+'**, does not have any corresponding pattern in Firefox patterns.

The 7 and 10 patterns identified for Chromium and GnuCash imply that developers in those projects also resolve issues in a variety of ways (as in Firefox).

These findings suggest that at least some of the Firefox patterns can be generalized to projects of different scales and governing structures, and developers in these projects also follow a variety of ways for issue resolution. While these findings are indicative, a large-scale study with a statistically significant sample of issue reports is required to validate these observations.

[1] https://www.mozilla.org/en-US/about/governance/
[2] https://tinyurl.com/2tnyw2cm

Bibliography

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