

May 14, 2023

Dear Prof. Feldt,

We are submitting the attached paper, “A Study of Common Bug Fix Patterns in Rust,” for publication in EMSE. This paper is an empirical study of the common bug fix patterns that we extracted from the most popular open-source Rust projects. Our primary contributions are as follows:

- We introduce Ruxanne, our pipeline for mining bug fix patterns in Rust. Ruxanne consists of different modules for parsing Rust programs, embedding the obtained ASTs after parsing in fixed sized datapoints, and clustering these fixed sized datapoints into different groups.
- We propose a novel code embedding method. Our method is simple, highly interpretable, and effective in capturing the most important aspects of a program change. Our code embedding approach is based on a flexible weighting scheme, which can be modified to serve to different purposes. Using this weighting scheme, we are able to give more weight to the elements that we deem more important.
- Using Ruxanne, we mined the top 18 most starred Rust projects in Github to discover common bug fix patterns within their code changes. We stored 87,726 datapoints drawn from 57,214 commits across these 18 projects. After using the DBSCAN clustering algorithm, and a subsequent manual analysis, we obtained 20 cross-project bug fix patterns. Given the crucial role of the Borrow-Checker module in Rust’s compiler, we introduce these patterns in two groups: 8 Borrow-Checker related and 12 general bug fix patterns.
- In the paper, we discuss how our findings can be useful for developing program repair and fault localization tools in Rust. Also, the patterns that we introduced can open up new linting opportunities for Rust code linters.
- Our work is most closely related to [1] and [2], which studied common bug patterns in JavaScript and Python; we instead consider Rust bug patterns. Rust greatly differs from JavaScript and Python in being statically typed and having strict static type checking, including ownership checking via the borrow checker. We believe that studying the question of bug patterns in a novel context is a valuable contribution.

We have not previously submitted any related work for publication in any venue.

Thank you for your consideration.

Mohammad Robati Shirzad and  
Patrick Lam

## References

- [1] Quinn Hanam, Fernando S de M Brito, and Ali Mesbah. Discovering bug patterns in JavaScript. In *Proceedings of the 2016 24th ACM SIGSOFT international symposium on foundations of software engineering*, pages 144–156, 2016.
- [2] Yilin Yang, Tianxing He, Yang Feng, Shaoying Liu, and Baowen Xu. Mining Python fix patterns via analyzing fine-grained source code changes. *Empirical Software Engineering*, 27(2):1–37, 2022.