Sup-Materials of RISC-V Compiler Issues Study

Anonymous Author(s)

In this subsection, we explore the relationships between various dimensions in the dataset, focusing on how different features such as impact, importance, root cause, temporal, and fixed time are interrelated. Understanding these correlations provides deeper insights into the characteristics of RISC-V compiler bugs.

Correlation Between Impact and Importance. Impact characterizes the observable consequences of a bug on the compiled program, such as incorrect output, performance degradation, or security vulnerabilities. In contrast, Importance reflects the urgency assigned to fixing a bug, considering factors such as development timelines, the criticality of the issue, and its potential to affect production use. Analyzing the correlation between Impact and Importance offers insight into whether bugs with severe functional consequences are consistently prioritized by developers.

We computed a Cramér's V coefficient of 0.243 between impact and importance, indicating a moderate association. The distribution of bugs across these two dimensions is shown in Figure 1. Functional issues, including wrong output and undefined behavior, are more frequently associated with higher priority levels (P1–P3), suggesting that correctness and stability remain central concerns during bug triage. A substantial portion of these bugs is labeled as highly important. Compatibility issues also show a similar pattern, further highlighting the emphasis placed on functional reliability. In contrast, performance-related tend to be assigned lower priority levels. This may reflect their less immediate impact on correctness, although their long-term effects on efficiency and maintainability should not be overlooked. These findings suggest that while developers prioritize correctness-critical issues, non-functional

Correlation Between Open Date and Root Cause. Analyzing the relationship between report date and root cause provides insight into the evolving nature of bugs and how their distribution changes as the compiler and its ecosystem mature. The Cramér's V coefficient for this relationship is 0.351, indicating a moderate correlation. Figure 2 shows the distribution of bug root causes across different reporting periods. Over time, the number of bugs related to compiler infrastructure has grown significantly, suggesting increasing complexity or technical debt within the compiler itself. Bugs stemming from architecture-specific features have also risen, albeit more gradually, reflecting ongoing efforts to support new or evolving RISC-V extensions. In contrast, issues related to external dependencies have increased at a relatively slower rate. These trends indicate that while the RISC-V ecosystem continues to evolve, the compiler's adaptation to its growing demands may face increasing challenges.

Correlation Between Open Date and Temporal. This analysis examines how the temporal stage characteristics of compiler bugs evolve over time. As the RISC-V ecosystem continues to mature, certain types of bugs may decrease in frequency, while others may become more prominent due to the introduction of new optimizations and features. This observation is supported by a Cramér's V coefficient of 0.401, suggesting a moderate correlation between

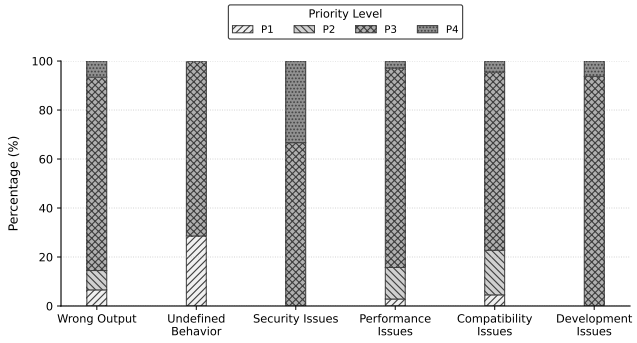

Figure 1: Correlation Between Priority Level and Impact

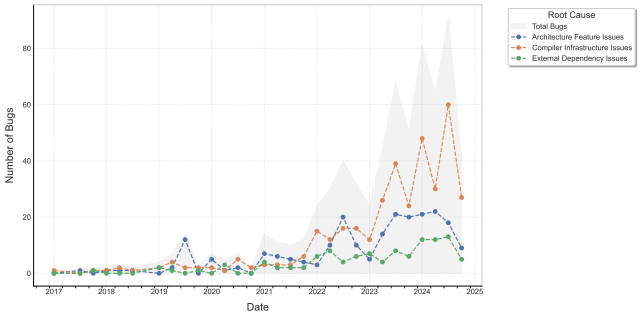

Figure 2: Distribution of Bug Root Causes Over Time

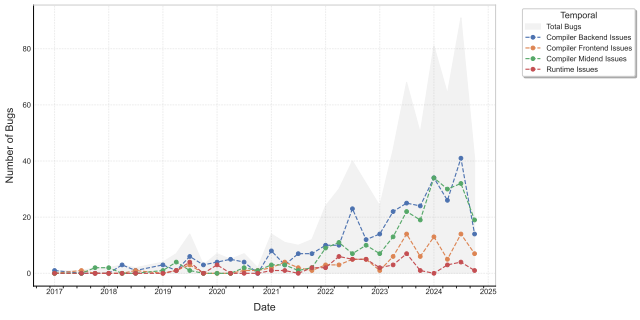

Figure 3: Temporal Stage Distribution of Bugs Over Time

the report date and the temporal stage classification of bugs. Figure 3 illustrates the distribution of temporal stage categories across different reporting periods. The data reveal an increasing trend in backend and midend issues, likely reflecting the growing complexity of RISC-V-specific optimizations. In contrast, frontend-related bugs have shown a slight decline, while runtime issues have also decreased, potentially indicating improved stability and maturity in front-end tooling.

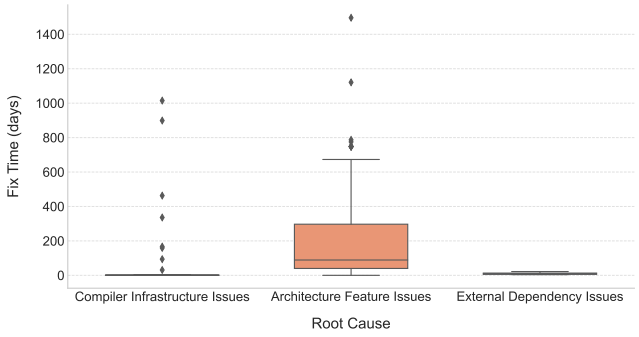

Figure 4: Correlation Between Root Cause and Fix Time

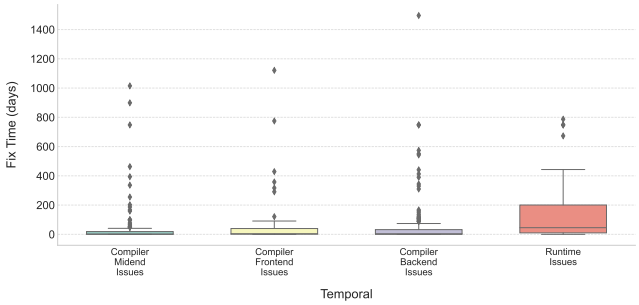

Figure 5: Correlation Between Temporal and Fix Time

Correlation Between Root Cause and Fixed Time. In this section, we analyze the relationship between root cause and the fixed time. Bugs originating from more complex areas of the compilation process, such as the RISC-V architecture, are likely to take longer to fix due to the technical complexity involved. The Cramér's V coefficient for this relationship is 0.518, indicating a strong correlation between Root Cause and Fixed Time.

Fig4 shows the distribution of fixed time across different root cause categories. The data reveals that architecture feature issues tend to take significantly longer to fix, with a median time of 45 days, compared to external dependency issues and compiler infrastructure issues, which are resolved in about 10 days and 12 days. This is consistent with the idea that bugs related to architecture features require more in-depth analysis and debugging.

Correlation Between Temporal and Fixed Time. Finally, we explore the relationship between the temporal and the fix time for bugs. During the middle and back-end stages of compilation, there are numerous intricate subprocesses, including optimization and code generation, which typically entail sophisticated analysis and adjustments, leading to extended error resolution times. The Cramér's V coefficient for this correlation is 0.347, indicating a moderate relationship between temporal and fix time.

Fig.5 visualizes this relationship. We observed that compiler frontend issues and compiler backend issues consistently exhibit longer resolution times compared to compiler midend issues. Furthermore, runtime issues demonstrate particularly prolonged resolution durations. We attribute this pattern to the strong correlation between runtime issues and architecture feature issues – the latter frequently requiring specialized RISC-V domain knowledge for effective diagnosis and remediation. This knowledge dependency inherently increases both the complexity and effort required to resolve such bugs.