

# A Study of Bugs Found in the Puppet Configuration Management System

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### 1. Background

Studying the bugs of complex systems improves their understanding and informs research into automated bug detection and prevention.

- Puppet manages machines based on a central configuration.
- Puppet is widely adopted in the industry with users in Twitter, Uber, and the NYSE.
- This study fills the research gap in this space.

### 2. Research Questions

What are the most common features of bugs in Puppet?

1. Symptoms.
2. Root causes.
3. Impact.
4. Triggers.
5. System dependency.
6. Fixes.

### 3. Methodology

1. Collected 10136 issue reports from Jira.
2. Collected 8906 pull requests and 34123 commits from Github.
3. Associated bug reports to fixes.
4. Analyzed a sample of 100 bugs [1].

### 4. Results

The distribution of each category in the 100 bug sample.

#### 1. Symptoms

Symptom	Percentage
Runtime Behavior	74.0%
Misleading Report	14.0%
Crash	9.0%
Other	3.0%

#### 2. Root Causes

Root Cause	Percentage
Misconfiguration	46.0%
Target Operation	31.0%
Error Handling Bug	13.0%
Controller Operation	10.0%

#### 3. Impact Consequence

Impact Consequence	Percentage
Config Inaccurate	21.0%
Config Failure	47.0%
Log Failure	18.0%
Config Incomplete	8.0%
Other	6.0%

#### 4. Trigger Reproduction

Trigger Reproduction	Percentage
Specific Execution	67.0%
Test Case	15.0%
OS Specific	11.0%
Other	7.0%

#### 5. System Dependency

System Dependency	Count
Windows	10
MacOS	1
Fedora	1
Solaris	3
AIX	1
Red Hat	1

#### 6. Conceptual Fix

Conceptual Fix	Percentage
Fix Executor	42.0%
Extend Executor	19.0%
Extend Parser	8.0%
Fix Parser	8.0%
Diagnostic	8.0%
Config	7.0%
Other	8.0%

### 5. Additional Contributions

Open-sourced and available for use.

- Artifacts and scripts.
- Data set of 2146 bugs with fixes.
- Bug study categorization tool.

### 6. Conclusions

- Applying automated bug detection methods like fuzz testing to the executor and parser would have the greatest return on investment.

### 7. Future Work

- Analyze a larger sample to solidify results.
- Research automated bug detection [2].

### 8. References

1. Chaliasos, S., Sotiropoulos, T., Drosos, G. P., Mitropoulos, C., Mitropoulos, D., & Spinellis, D. (2021). Well-typed programs can go wrong: a study of typing-related bugs in JVM compilers. Proceedings of the ACM on Programming Languages, 5(OOPSLA), 1–30. <https://doi.org/10.1145/3485500>
2. Sotiropoulos, T., Mitropoulos, D., & Spinellis, D. (2020). Practical fault detection in puppet programs. Proceedings of the ACM/IEEE 42nd International Conference on Software Engineering. <https://doi.org/10.1145/3377811.3380384>