C-FLASH: Concurrency Faults Localized Automatically using Search Heuristics

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1. Motivation

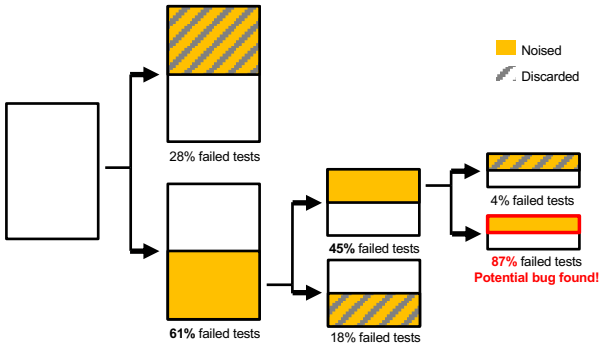
- Multicore processors have allowed for great improvements in performance – if software is concurrent!
- Unfortunately, the nondeterministic nature of concurrent programs make them challenging to develop and test [1].
- The results of concurrency testing can vary for different thread interleavings (i.e., execution schedules) [2].

RESEARCH GOAL:
Create a development tool that automatically localizes concurrency bugs, given a unit of source code and a set of tests.

2. Background

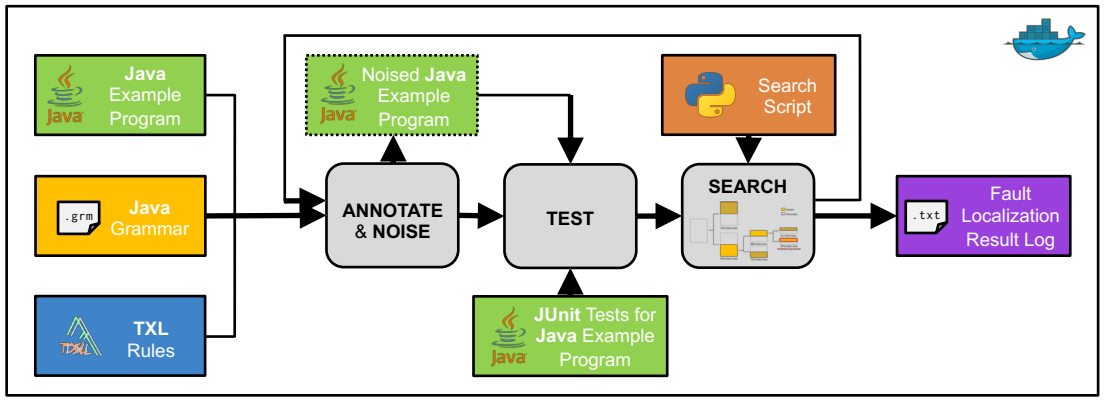
- **Concurrency bugs** can manifest themselves in some thread interleavings but not in others.
- **Concurrency testing** needs to test a concurrent program with many different interleavings.
- **Noising** is the process of inserting random delays around critical areas in in a concurrent program. By using noising, we can control thread delays and explore different execution outcomes [3].

3. Fault Localization Strategy



- Binary search approach where each section of code is divided into two sections. Each section is noised using TXL [4] and then tested separately.
- The test results for each noised section are compared and the section that exhibited a higher rate of failed tests is further split until the unit level of source code is reached.

4. Process Overview



5. Preliminary Evaluation

- To evaluate the effectiveness of **C-FLASH** we have performed bug localization on several programs from the IBM Concurrency Benchmark [5], each of which have a known data race or deadlock.
- Our preliminary results show **C-FLASH** to be effective at finding the location of a known bug in our test programs – identifying the correct synchronization block or method containing the bug.
- Next, we plan to conduct a thorough evaluation using a set of large-scale, real-life concurrent programs.

6. Conclusions and Future Work

- **C-FLASH** is a modernized and portable version of SyncDebugger, an earlier bug localization prototype [6].
- **C-FLASH** vs. SyncDebugger – the primary enhancements include:
  - Full automation of the bug localization search strategy.
  - Performance optimizations in the annotation and noising of concurrent programs under test.
  - Portability across platforms using Docker.
- The efficiency of **C-FLASH** is also of high importance in our research. In order to better optimize the bug localization process, we plan to:
  - Explore efficient search algorithms that fit our objective.
  - Parallelize our current approach, allowing for different parts of a system to be analyzed simultaneously.

7. References

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CASCON 2018 Technology Expo • **Markham, ON, Canada** • **October 2018**

FUNDING PROVIDED BY: NSERC CRSNG