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Combining Symmetry- and Barrier-Aware Reduction in GenMC

Bachelor Thesis Description

Summary

GenMC is a stateless model checker that can verify safety properties of a C/C++ program by enumerating all of its executions. As the number of executions grows exponentially as programs get larger, GenMC employs various optimizations to reduce the state-space size, such as symmetry reduction (SR) and barrier-aware reduction (BAR). SR avoids exploring executions equivalent up to some permutation of symmetric threads, while BAR avoids exploring executions that only differ in the order, different threads rendezvous at a barrier. While both optimizations perform well individually, their combination in the context of stateless model checking has not been investigated.

This thesis aims to combine SR and BAR into GenMC so that threads, the symmetry of which has broken (e.g., due to them reading different values), can be considered symmetric again, after rendezvousing at a barrier. The goal is to identify (static) conditions when this is the case, and implement them in the tool.

Core Goals

1. Study SR and BAR and familiarize with GenMC's architecture. Run existing tests to gain familiarity with the tool (1 week)
2. Revise GenMC's modeling of barriers so that it supports more than one rendezvous at the same barrier (1 week)
3. Find programs where SR is broken but can be restored after a barrier rendezvous. Identify and formalize conditions for when this is the case (1 week)
4. Implement aforementioned conditions in GenMC (1 week)
5. Write thesis (2 weeks)

Extension Goals

1. Find a codebase with barriers and verify it using GenMC (0.5 week)
2. Find cases where the found conditions might not hold and implement code transformations so that the conditions hold (0.5 week)
3. Optimize the implementation by reducing time spent on consistency checking in programs with barriers (0.5 week)

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