Ultimate Eliminator at SMT-COMP 2023

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Abstract

Ultimate Eliminator is a tool for eliminating quantifiers in SMT formulas. At the SMT-COMP 2023 we participate with a user interface that takes SMT-LIB 2.6 compatible input, tries to eliminate quantifiers in this input and passes the modified input to the MathSAT SMT solver. The first three sections of this system decription were copied from last year's submission. In Section 4 we present some technical data of this year's tool.

1 Overview

Quantified formulas are notoriously difficult to solve and several state-of-the-art SMT solvers support only quantifier-free formulas. We found out that, perhaps surprisingly, the quantifier elimination algorithms that are implemented in the Ultimate software verification framework can often find quantifier-free formulas that are logically equivalent to formulas in SMT-LIB benchmarks. Hence, these quantifier elimination algorithms empower existing SMT solvers without support for quantifiers to solve quantified formulas. E.g., a formula of the form $\exists x.\varphi(x) \wedge x = t$ is transformed to $\varphi(t)$ and the formula $\forall a.select(a,k) = select(a,i)$ is transformed to $k = i$.

2 Quantifier Elimination in Ultimate

A key algorithm [2] of several software verifiers [3] in the Ultimate framework [1] does an iterative application of the strongest post predicate transformer to a sequence of statements resp. an iterative application of the weakest precondition predicate transfomer. Both variants of the algorithm produce quantified formulas and the handling of these quantified formulas often was a bottleneck for the overall software verification approach. The performance of the tool improved significantly when the developers started to apply quantifier elimination techniques to every intermediate result. As a consequence, in the last years an increasing number of quantifier elimination techniques was implemented into the Ultimate framework.

3 Ultimate Eliminator

Ultimate Eliminator[2] is a user interface that takes SMT-LIB 2.6 compatible input, tries to eliminate quantifiers in this input and passes the modified input to a user defined SMT-LIB 2.6 compatible solver. Ultimate Eliminator is implemented in Java as a plug-in of the Ultimate framework. The source code is available in a public repository[3].

[1] https://ultimate.informatik.uni-freiburg.de/
[2] https://ultimate.informatik.uni-freiburg.de/eliminator/
[3] https://github.com/ultimate-pa/ultimate/

4 SMT-COMP 2023 Submission

We submitted a version of Ultimate Eliminator that wraps the MathSAT SMT solver[4][1] and participate only in divisions with quantifiers. Our UltimateEliminator+MathSAT-5.6.9 submission wraps the version 5.6.9 of the MathSAT SMT solver. We call MathSAT without any additonal arguments. Since StarExec does not yet support Java 11, we added OpenJDK 11.0.2+9 to our archive. Adding OpenJDK increased the size of our archive from about 15MiB to about 200MiB.

Our wrapper tool participates in the Single Query Track, in the Incremental Track, and in the Unsat Core Track.

References

[1] Alessandro Cimatti, Alberto Griggio, Bastiaan Joost Schaafsma, and Roberto Sebastiani. The mathsat5 SMT solver. In Nir Piterman and Scott A. Smolka, editors, *Tools and Algorithms for the Construction and Analysis of Systems - 19th International Conference, TACAS 2013, Held as Part of the European Joint Conferences on Theory and Practice of Software, ETAPS 2013, Rome, Italy, March 16-24, 2013. Proceedings*, volume 7795 of *Lecture Notes in Computer Science*, pages 93–107. Springer, 2013.

[2] Daniel Dietsch, Matthias Heizmann, Betim Musa, Alexander Nutz, and Andreas Podelski. Craig vs. newton in software model checking. In Eric Bodden, Wilhelm Schäfer, Arie van Deursen, and Andrea Zisman, editors, *Proceedings of the 2017 11th Joint Meeting on Foundations of Software Engineering, ESEC/FSE 2017, Paderborn, Germany, September 4-8, 2017*, pages 487–497. ACM, 2017.

[3] Matthias Heizmann, Max Barth, Daniel Dietsch, Leonard Fichtner, Jochen Hoenicke, Dominik Klumpp, Mehdi Naouar, Tanja Schindler, Frank Schüssele, and Andreas Podelski. Ultimate automizer and the commuhash normal form - (competition contribution). In Sriram Sankaranarayanan and Natasha Sharygina, editors, *Tools and Algorithms for the Construction and Analysis of Systems - 29th International Conference, TACAS 2023, Held as Part of the European Joint Conferences on Theory and Practice of Software, ETAPS 2022, Paris, France, April 22-27, 2023, Proceedings, Part II*, volume 13994 of *Lecture Notes in Computer Science*, pages 577–581. Springer, 2023.

[4] http://mathsat.fbk.eu/