Deciding LTL over Mazukiewicz Traces

Benedikt Bollig
Martin Leucker
The publications of the Department of Computer Science of RWTH Aachen University are in general accessible through the World Wide Web.

http://aib.informatik.rwth-aachen.de/
Deciding LTL over Mazurkiewicz Traces

Benedikt Bollig and Martin Leucker
Lehrstuhl für Informatik II
RWTH Aachen, Germany
Email: {bollig, leucker}@informatik.rwth-aachen.de

Abstract. Linear time temporal logic (LTL) has become a well established tool for specifying the dynamic behaviour of reactive systems with an interleaving semantics, and the automata-theoretic approach has proven to be a very useful mechanism for performing automatic verification in this setting. Especially alternating automata turned out to be a powerful tool in constructing efficient yet simple to understand decision procedures and directly yield further on-the-fly model checking procedures. In this paper we exhibit a decision procedure for LTL over Mazurkiewicz traces which generalises the classical automata-theoretic approach to a linear time temporal logic interpreted no longer over sequences but certain partial orders. Specifically, we construct a (linear) alternating Büchi automaton accepting the set of linearisations of traces satisfying the formula at hand. The salient point of our technique is to apply a notion of independence-rewriting to formulas of the logic. Furthermore, we show that the class of linear and trace-consistent alternating Büchi automata corresponds exactly to LTL formulas over Mazurkiewicz traces, lifting a similar result from Löding and Thomas formulated in the framework of LTL over words.

1 Introduction

Linear time Temporal Logic (LTL) as proposed by Pnueli [Pnu77] has become a well established tool for specifying the dynamic behaviour of distributed systems. The traditional approach towards automatic program verification is model checking specifications in LTL. A basic feature of LTL has been that its formulas are interpreted over sequences. Typically, such a sequence will model a computation of a system; a sequence of states visited by the system or a sequence of actions executed by the system during the course of the computation.

* Part of this work was done during the second author’s stay at BRICS. He is grateful for the hospitality and the overall support.
References

Aachener Informatik-Berichte

This list contains all technical reports published during the past three years. A complete list of reports dating back to 1987 is available from:

http://aib.informatik.rwth-aachen.de/

To obtain copies please consult the above URL or send your request to:

Informatik-Bibliothek, RWTH Aachen, Ahornstr. 55, 52056 Aachen,
Email: biblio@informatik.rwth-aachen.de

2014-02 Daniel Merschen: Integration und Analyse von Artefakten in der modellbasierten Entwicklung eingebetteter Software
2014-03 Uwe Naumann, Klaus Leppkes, and Johannes Lotz: dco/c++ User Guide
2014-04 Namit Chaturvedi: Languages of Infinite Traces and Deterministic Asynchronous Automata
2014-05 Thomas Ströder, Jürgen Giesl, Marc Brockschmidt, Florian Frohn, Carsten Fuhs, Jera Hensel, and Peter Schneider-Kamp: Automated Termination Analysis for Programs with Pointer Arithmetic
2014-06 Esther Horbert, Germán Martín García, Simone Frintrop, and Bastian Leibe: Sequence Level Salient Object Proposals for Generic Object Detection in Video
2014-08 Christina Jansen, Florian Göbe, and Thomas Noll: Generating Inductive Predicates for Symbolic Execution of Pointer-Manipulating Programs
2015-05 Florian Frohn, Jürgen Giesl, Jera Hensel, Cornelius Aschermann, and Thomas Ströder: Inferring Lower Bounds for Runtime Complexity
2015-06 Thomas Ströder and Wolfgang Thomas (Editors): Proceedings of the Young Researchers’ Conference “Frontiers of Formal Methods”
2015-07 Hilal Diab: Experimental Validation and Mathematical Analysis of Cooperative Vehicles in a Platoon
2015-09 Xin Chen: Reachability Analysis of Non-Linear Hybrid Systems Using Taylor Models
2015-11 Stefan Wüller, Marián Kühnel, and Ulrike Meyer: Information Hiding in the Public RSA Modulus
2015-12 Christoph Matheja, Christina Jansen, and Thomas Noll: Tree-like Grammars and Separation Logic
2015-13 Andreas Polzer: Ansatz zur variantenreichen und modellbasierten Entwicklung von eingebetteten Systemen unter Berücksichtigung regelungstechnischer Anforderungen
2015-14 Niloofar Safiran and Uwe Naumann: Symbolic vs. Algorithmic Differentiation of GSL Integration Routines
2016-02 Ibtissem Ben Makhlouf: Comparative Evaluation and Improvement of Computational Approaches to Reachability Analysis of Linear Hybrid Systems
2016-03 Florian Frohn, Matthias Naaf, Jera Hensel, Marc Brockschmidt, and Jürgen Giesl: Lower Runtime Bounds for Integer Programs
2016-04 Jera Hensel, Jürgen Giesl, Florian Frohn, and Thomas Ströder: Proving Termination of Programs with Bitvector Arithmetic by Symbolic Execution
2016-06 Martin Henze, René Hummen, Roman Matzutt, Klaus Wehrle: The SensorCloud Protocol: Securely Outsourcing Sensor Data to the Cloud
2016-07 Sebastian Biallas: Verification of Programmable Logic Controller Code using Model Checking and Static Analysis
2016-08 Klaus Leppkes, Johannes Lotz, and Uwe Naumann: Derivative Code by Overloading in C++ (dco/c++): Introduction and Summary of Features
2016-09 Thomas Ströder, Jürgen Giesl, Marc Brockschmidt, Florian Frohn, Carsten Fuhs, Jera Hensel, Peter Schneider-Kamp, and Cornelius Aschermann: Automatically Proving Termination and Memory Safety for Programs with Pointer Arithmetic

2016-10 Stefan Wüller, Ulrike Meyer, and Susanne Wetzel: Towards Privacy-Preserving Multi-Party Bartering

2017-01 * Fachgruppe Informatik: Annual Report 2017

2017-02 Florian Frohn and Jürgen Giesl: Analyzing Runtime Complexity via Innermost Runtime Complexity

2017-04 Florian Frohn and Jürgen Giesl: Complexity Analysis for Java with AProVE

2017-05 Matthias Naaf, Florian Frohn, Marc Brockschmidt, Carsten Fuhs, and Jürgen Giesl: Complexity Analysis for Term Rewriting by Integer Transition Systems

2017-06 Oliver Kautz, Shahar Maoz, Jan Oliver Ringert, and Bernhard Rumpe: CD2Alloy: A Translation of Class Diagrams to Alloy

* These reports are only available as a printed version.
Please contact bibli@informatik.rwth-aachen.de to obtain copies.