Contributions to the theory and applications of tree languages.

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2007 (English)Doctoral thesis, comprehensive summary (Other academic)

Abstract [en]

This thesis is concerned with theoretical as well as practical aspects of tree languages. It consists of an introduction and eight papers, organised into three parts. The ï¬ rst part is devoted to algorithmic learning of regular tree languages, the second part to bisimulation minimisation of tree automata, and the third part to tree-based generation of music. We now summarise the contributions made in each part.

In Part I, an inference algorithm for regular tree languages is presented. The algorithm is a generalisation of a previous algorithm by Angluin, and the learning task is to derive, with the aid of a so-called MAT-oracle, the minimal (partial and deterministic) ï¬ nite tree automaton M that recognises the target language U over some ranked alphabet Î£. The algorithm executes in time O(|Q| |Î´| (m + |Q|)), where Q and Î´ are the set of states and the transition table of M , respectively, r is the maximal rank of any symbol in Î£, and m is the maximum size of any answer given by the oracle. This improves on a similar algorithm by Sakakibara as dead states are avoided both in the learning phase and in the resulting automaton. Part I also describes a concrete implementation which includes two extensions of the basic algorithm.

In Part II, bisimulation minimisation of nondeterministic weighted tree automata (henceforth, wta) is introduced in general, and for ï¬ nite tree automata

(which can be seen as wta over the Boolean semiring) in particular. The concepts of backward and forward bisimulation are extended to wta, and eï¬*f*cient minimisation algorithms are developed for both types of bisimulation. In the special case where the underlying semiring of the input automaton is either cancellative or Boolean, these minimisation algorithms can be further optimised by adapting existing partition reï¬ nement algorithms by Hopcroft, Paige, and Tarjan. The implemented minimisation algorithms are demonstrated on a typical task in natural language processing.

In Part III, we consider how tree-based generation can be applied to algorithmic composition. An algebra is presented whose operations act on musical pieces, and a system capable of generating simple musical pieces is implemented in the software Treebag: starting from input which is either generated by a regular tree grammar or provided by the user via a digital keyboard, a number of top-down tree transducers are applied to generate a tree over the operations provided by the music algebra. The evaluation of this tree yields the musical piece generated.

Place, publisher, year, edition, pages

UmeÃ¥: Datavetenskap , 2007. , p. 32

Series

Report / UMINF, ISSN 0348-0542 ; 07.07

Keywords [en]

regular tree languages, tree series, algorithmic learning, MAT-learning, bisimulation minimisation, tree-based generation, algorithmic composition, music algebra

National Category

Computer Sciences

Identifiers

URN: urn:nbn:se:umu:diva-1152ISBN: 978-91-7264-336-9 (print)OAI: oai:DiVA.org:umu-1152DiVA, id: diva2:140401

Public defence

2007-09-07, MA121, MIT huset, UmeÃ¥ Universitet, UmeÃ¥, 13:00 (English)

Opponent

Droste, Manfred, Prof. Dr.

Supervisors

Drewes, Frank, Docent

Available from: 2007-05-16 Created: 2007-05-16 Last updated: 2018-06-09Bibliographically approved

List of papers

1. Learning a regular tree language from a teacher
2. Query Learning of Regular Tree Languages: How to Avoid Dead States
3. Extensions of a MAT Learner for Regular Tree Languages
4. Bisimulation minimization of tree automata
5. Backward and forward bisimulation minimisation of tree automata
6. Bisimulation minimisation for weighted tree automata
7. Wind in the Willows: generating music by means of tree transducers
8. An Algebra for Tree-Based Music Generation

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