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Order-Preserving Graph Grammars

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Abstract

The field of *semantic modelling* concerns formal models for semantics, that is, formal structures for the computational and algorithmic processing of *meaning*. This thesis concerns formal *graph languages* motivated by this field. In particular, we investigate two formalisms: Order-Preserving DAG Grammars (OPDG) and Order-Preserving Hyperedge Replacement Grammars (OPHG), where OPHG generalise OPDG.

Graph parsing is the practise of, given a graph grammar and a graph, to determine if, and in which way, the grammar could have generated the graph. If the grammar is considered fixed, it is the *non-uniform* graph parsing problem, while if the grammars is considered part of the input, it is named the *uniform* graph parsing problem. Most graph grammars have parsing problems known to be NP-complete, or even exponential, even in the non-uniform case. We show both OPDG and OPHG to have polynomial uniform parsing problems, under certain assumptions.

We also show these parsing algorithms to be suitable, not just for determining membership in graph languages, but for computing weights of graphs in *graph series*.

Additionally, OPDG is shown to have several properties common to regular languages, such as MSO definability and MAT learnability. We moreover show a direct correspondence between OPDG and the regular tree grammars.

Finally, we present some limited practical experiments showing that real-world semantic graphs appear to mostly conform to the requirements set by OPDG, after minimal, reversible processing.

Keywords

Graph grammars, graph parsing, graph series, hyperedge replacement, uniform parsing problem, abstract meaning representation, semantic modelling, order preservation, reentrancy preservation, minimally adequate teacher, weighted graph grammars

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