

Courcelle's Theorem – A Game-Theoretic Approach

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Courcelle's Theorem states that every problem definable in Monadic Second-Order logic can be solved in linear time on structures of bounded treewidth, for example, by constructing a tree automaton that recognizes or rejects a tree decomposition of the structure. Existing, optimized software like the MONA tool can be used to build the corresponding tree automata, which for bounded treewidth are of constant size. Unfortunately, the constants involved can become extremely large – every quantifier alternation requires a power set construction for the automaton. Here, the required space can become a problem in practical applications. In this paper, we present a novel, direct approach based on model checking games, which avoids the expensive power set construction. Experiments with an implementation are promising, and we can solve problems on graphs where the automata-theoretic approach fails in practice.

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