Efficient Algorithms for Handling Nondeterministic Automata

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Finite (word, tree, or omega) automata play an important role in different areas of computer science, including, for instance, formal verification. Often, deterministic automata are used for which traditional algorithms for important operations such as minimisation and inclusion checking are available. However, the use of deterministic automata implies a need to determinise nondeterministic automata that often arise during various computations even when the computations start with deterministic automata. Unfortunately, determinisation is a very expensive step since deterministic automata may be exponentially bigger than the original nondeterministic automata. That is why, it appears advantageous to avoid determinisation and work directly with nondeterministic automata. This, however, brings a need to be able to implement operations traditionally done on deterministic automata on nondeterministic automata instead. In particular, this is the case of inclusion checking and minimisation (or rather reduction of the size of automata). In the talk, we review several recently proposed techniques for inclusion checking on nondeterministic finite word and tree automata as well as Büchi automata. These techniques are based on using the so called antichains, possibly combined with a use of suitable simulation relations (and, in the case of Büchi automata, the so called Ramsey-based or rank-based approaches). Further, we discuss techniques for reducing the size of nondeterministic word and tree automata using quotienting based on the recently proposed notion of mediated equivalences. The talk is based on several common works with Parosh Aziz Abdulla, Ahmed Bouajjani, Yu-Fang Chen, Peter Habermehl, Lisa Kaati, Richard Mayr, Tayssir Touili, Lorenzo Clemente, Lukáš Holík, and Chih-Duo Hong.

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