Weighted Automata and Logics on Hierarchical Structures and Graphs

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Abstract

Formal language theory, originally developed to model and study our natural spoken languages, is nowadays also put to use in many other fields. These include, but are not limited to, the definition and visualization of programming languages and the examination and verification of algorithms and systems. Formal languages are instrumental in proving the correct behavior of automated systems, e.g., to avoid that a flight guidance system navigates two airplanes too close to each other.

This vast field of applications is built upon a very well investigated and coherent theoretical basis. It is the goal of this dissertation to add to this theoretical foundation and to explore ways to make formal languages and their models more expressive. More specifically, we are interested in models that are able to model *quantitative* features of the behavior of systems. To this end, we define and characterize weighted automata over structures with hierarchical information and over graphs.

In particular, we study *infinite nested words*, *operator precedence languages*, and *finite* and *infinite graphs*. We show Büchi-like results connecting weighted automata and weighted monadic second order (MSO) logic for the respective classes of weighted languages over these structures. As special cases, we obtain Büchi-type equivalence results known from the recent literature for weighted automata and weighted logics on words, trees, pictures, and nested words. Establishing such a general result for graphs has been an open problem for weighted logics for some time. We conjecture that our techniques can be applied to derive similar equivalence results in other contexts like traces, texts, and distributed systems.