

Nondeterminism and Determinism in Regular Languages: a derivative-based approach

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Abstract.

Regular languages are omnipresent in Computer Science, with applications in pattern recognition, software certification and verification, cryptography and cryptographic protocols, quantum computing, web services, communication codes, and more.

Regular expressions are a common choice to represent regular languages due to their succinctness and clear syntax. Deterministic finite automata are an excellent representation for testing equivalence, containment, or membership, as these problems are easily solved for this model. However, minimal deterministic finite automata can be exponentially larger than the associated regular expression, while corresponding nondeterministic finite automata are at most linearly larger. Although the computational and descriptive complexity of regular expressions and of conversions to and from finite automata are well studied in the worst case, it is still challenging to characterize operations, models, or subregular language classes for which the exponential blow-up can be avoided. On the other hand, the average-case complexity of these models is largely unknown. In recent years, the average size of some finite automata constructions from regular expressions has been studied using the framework of analytic combinatorics. In this context, the notions of derivative and partial derivative are not only elegant and powerful tools, but have also been successfully extended to many other formal language classes and algebraic structures. This talk gives a brief historical overview and summarizes some of these aspects.