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k-Universality of Regular Languages

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Abstract

A subsequence of a word w is a word u such that $u = w[i_1]w[i_2]\dots w[i_k]$, for some set of indices $1 \leq i_1 < i_2 < \cdots < i_k \leq |w|$. A word w is k-subsequence universal over an alphabet Σ if every word in Σ^k appears in w as a subsequence. In this talk, we focus on the intersection between the set of k-subsequence universal words over some alphabet Σ and regular languages over Σ. We call a regular language L k-$\exists$-*subsequence universal* if there exists a k-subsequence universal word in L, and k-$\forall$-*subsequence universal* if every word of L is k-subsequence universal. We present algorithms solving the problems of deciding if a given regular language, represented by a finite automaton accepting it, is k-$\exists$-*subsequence universal* and, respectively, if it is k-$\forall$-*subsequence universal*, for a given number k. The algorithms are FPT w.r.t. the size of the input alphabet, and their run-time does not depend on k; they run in polynomial time in the number n of states of the input automaton when the size of the input alphabet is $O(\log n)$. Moreover, we show that the problem of deciding if a given regular language is k-$\exists$-*subsequence universal* is NP-complete, when the language is over a large alphabet. Further, we provide algorithms for counting the number of k-subsequence universal words (paths) accepted by a given deterministic (respectively, nondeterministic) finite automaton, and ranking an input word (path) within the set of k-subsequence universal words accepted by a given finite automaton.

The paper on which this talk is based is accepted at ISAAC 2023 [1].

References

[1] D. ADAMSON, P. FLEISCHMANN, A. HUCH, T. KOSS, F. MANEA, D. NOWOTKA, k-Universality of Regular Languages. In: *ISAAC 2023, Proceedings*. LIPIcs (and full version on Arxiv), to appear, 2023.