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Constructing Universal Cycles for Fixed-Content Strings

Consider the circular string 123313321323 of length twelve. Its substrings of length three — 123, 233, 331, ..., 231, 312 — encode the twelve permutations of the multiset $\{1, 2, 3, 3\}$ with the redundant final symbol omitted. We provide the first explicit construction of these fixed-content universal cycles, along with efficient algorithms that generate each successive symbol in amortized $O(1)$ -time, regardless of the specific multiset of symbols.

When universal cycles of this type are decoded, the resulting order of strings (e.g. 1233, 2331, 3312, ..., 2313, 3123) have a nice property: Successive strings differ by a prefix rotation of length n or $n - 1$. We illustrate how this property can be used to speed-up exhaustive computations for the stacker crane problem, and other combinatorial problems whose candidate solutions can be represented by fixed-content strings.

Joint work with Joe Sawada (University of Guelph).