

Constrained Orthogonal de Bruijn Sequences and Graphs

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A de Bruijn sequence of order k over a finite alphabet is a cyclic sequence with the property that it contains every possible k -sequence as a substring exactly once. Orthogonal de Bruijn sequences are collections of de Bruijn sequences of the same order k , satisfying the joint constraint that every $(k+1)$ -sequence appears as a substring in at most one of the sequences in the collection. Both de Bruijn and orthogonal de Bruijn sequences have found numerous applications in synthetic biology, although the latter remain largely unexplored in the coding theory literature. Here we study three relevant practical generalizations of orthogonal de Bruijn sequences where we relax either the constraint that every $(k+1)$ -sequence appears exactly once, or that the sequences themselves are de Bruijn rather than balanced de Bruijn sequences. We also provide lower and upper bounds on the number of fixed-weight orthogonal de Bruijn sequences. The paper concludes with parallel results for orthogonal nonbinary Kautz sequences, which satisfy similar constraints as de Bruijn sequences except for only being required to cover all subsequences of length k whose maximum runlength equals to one.

In Special Session 40 on Network Coding and Related Fields at the Mathematical Congress of the Americas 2025.