Combinatorial Design Theory
Théorie des plans combinatoires
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Length-Maximal Nonlinear Codes with Given Singleton Defect–Structure and Bounds

For a linear $[n,k,d]_q$ code, the columns of a generator matrix form a projective arc, and the maximum length is governed by the classical maximal-arc bound $n \leq (s+1)(q+1)+k-2$, where s is the Singleton defect. We show that this same bound holds for all $(n,q^k,d)_q$ codes, with no assumption of linearity. Codes attaining the bound, which we call length-maximal, are necessarily symbol-uniform and have a sharply constrained distance spectrum. They also satisfy a divisibility condition on s that mirrors, but is weaker than, the condition forced on linear codes. An equivalent form of the bound yields an improved Singleton-type inequality that recovers and extends a result of Guerrini, Meneghetti, and Sala for binary systematic codes. When the defect is large, the bound tightens in discrete steps. We also identify several conditions under which nonlinear codes satisfy the Griesmer bound, and close with open problems, grounded by the central question: *can genuinely nonlinear length-maximal codes exist for parameters where no linear codes do*?

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Edge-connectivity of vertex-transitive hypergraphs

A graph or hypergraph is said to be vertex-transitive if its automorphism group acts transitively upon its vertices. A classic theorem of Mader asserts that every connected vertex-transitive graph is maximally edge-connected. We generalise this result to hypergraphs and show that every connected linear uniform vertex-transitive hypergraph is maximally edge-connected. By using combinatorial designs, we also show that if we relax either the linear or uniform conditions in this generalisation, then we can construct examples of vertex-transitive hypergraphs which are not maximally edge-connected. This is joint work with Andrea Burgess and Robert Luther.

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