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Finite Field Constructions of Combinatorial Arrays

Finite fields play a fundamental role in the construction of combinatorial designs. In an article of the same title with Gary Mullen and Daniel Panario (Designs, Codes and Cryptography, 2016), we survey constructions of combinatorial arrays using finite fields. These combinatorial objects include orthogonal arrays, covering arrays, ordered orthogonal arrays, permutation arrays, frequency permutation arrays, hypercubes and Costas arrays.

In this talk, I briefly discuss finite field constructions of various types of combinatorial arrays. Then, I focus on constructions of orthogonal arrays and related objects such as variable strength orthogonal arrays, ordered orthogonal arrays and covering arrays. An orthogonal array (and its variants) is an array with q^t rows and k columns on an alphabet with q symbols such that its projection into specific t-subsets of columns give subarrays where each t-tuple of the alphabet occurs once as one of its rows. The orthogonal array variants differ in which t-subsets of columns are required to have this "coverage property". A common theme on several of the recent constructions we discuss is the use of linear feedback shift register sequences of maximum period (m-sequences) to build arrays attaining a high number of t-subsets of columns with the "coverage property". The structure of coverage in the arrays built from intervals of length $(q^t-1)/(q-1)$ of these sequences reveal interesting relationships with finite geometry. I will mention different constructions I have worked on with André Castoldi, Sebastian Raaphorst, Daniel Panario, Brett Stevens and Georgios Tzanakis.