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Hypergraph-dependent Covering Arrays

In this talk, we discuss generalizations of cover-free families and covering arrays that use a hypergraph to specify coverage.

A d-CFF(t,n) is a $t \times n$ array such that for each subset of $d+1$ columns, every possible weight-1 binary tuple occurs in at least one of the rows. CFFs are used in combinatorial group testing to determine up to d defective items in a collection of n items by pooling items to be tested together in t tests; the defective items are deduced from the test results.

A covering array (CA) of size N, strength t, k factors and alphabet size v is an $N \times k$ array such that for each subset of t columns, every possible t-tuple of the alphabet occurs in at least one of the rows. CAs give effective test suits for software testing giving a good coverage of the parameter space.

Both types of array require that "coverage" must occur in every subset of columns of a fixed size. The number of rows/tests must be minimized and it grows as the logarithm of the number of columns. In the hypergraph-dependent versions of these problems, edges of a hypergraph specify in which columns "coverage" is required. The hypergraph model for CAs has been studied since Meagher&Stevens (2005). The hypergraph model for CFFs was introduced by Idalino and Moura (IWOCA2022), motivated by applications in pandemic screening, where fewer tests are needed by using knowledge about connected communities.

We will overview known results and future work on hypergraph-dependent covering arrays.