
Practical Applications of Design Theory - Part II

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CHARLIE COLBOURN, Arizona State University

Popularity Block Ordering for Steiner Systems

Steiner systems are used for data layout in distributed storage systems. However, assignment of data items to storage units often ignores the long-term item popularity. To address popularity, we order the blocks of a design, computing the point sum of an element as the sum of the indices of blocks containing that element. Popularity block ordering asks for the point sums to be as equal as possible. Remarkably, for many parameter sets, the blocks of a Steiner system can be ordered to make all point sums equal! In this talk, we outline some techniques for constructing such egalitarian Steiner systems.

PETER DUKES, University of Victoria

The use of graph decompositions for variance-balanced designs in the presence of correlated errors

Designs have a long tradition in statistical experiments. A standard model is

$$y_{ij} = \theta_i + \beta_j + \epsilon_{ij},$$

where y_{ij} is an observed value for treatment i in block j , θ_i is a treatment effect, β_j is a block effect, and ϵ_{ij} are i.i.d. errors.

The covariance matrix for the least-squares estimator $\hat{\theta}$ is computed from the design incidence matrix. When a BIBD is used for the model, $\text{Cov}(\hat{\theta})$ is a linear combination of I and J , something statistically desirable.

This research explores graph decompositions in place of BIBDs when ϵ_{ij} are correlated, say for spatial or temporal reasons.

GUANG GONG, University of Waterloo

Polynomials, Sequences and Complementary Codes

In this talk, I will present our recent results on how to recursively construct Golay complementary sequences (GCS) and complete complementary codes (CCC) using unitary matrices with polynomial entries (the so-called PU matrix method) and how to retrieve their multi-linear multivariate polynomial representation. In this way, we have constructed abundant new GCS/CCC and include all the known cases as our special cases. Especially, we have discovered an extremely fascinating hidden connection between these sequences and sequences with 2-level autocorrelation, which are two completely separate fields in the literature for more than 7 decades.

KIRSTEN NELSON, Carleton University

Construction of Covering Arrays from Interleaved Sequences

A covering array $CA(N; t, k, v)$ is an $N \times k$ array over an alphabet of v elements such that for any t -set of columns, each possible arrangement of t alphabet elements occurs at least once in a row. Finding the smallest number of rows N is a central problem. We will examine interleaved sequences, created by combining a base sequence with desirable coverage properties with a shift sequence. We show what properties are inherited from the base sequence, and by which shift sequences. Finally, we demonstrate the potential for interleaved sequences to create ϵ -almost covering arrays.

DANIEL PANARIO, Carleton University

LDPC codes based on trade designs

Low-Density Parity-Check (LDPC) codes are a practically important class of linear codes. We provide a novel approach to construct the parity-check matrix of an LDPC code with girth at least 6 using trades of directed designs. Then we use those trade-based matrices to construct a base matrix of a multiple-edge quasi-cyclic LDPC code with improved cycle detection and reduced computational complexity. We also use trade-based matrices to construct the parity-check matrix of time-varying spatially-coupled LDPC codes. These techniques are structural and applicable to any directed design. Joint work with Farzane Amirzade and Mohammad Sadeghi.