Orthogonalized Moment Aberration for Multi-Stratum Factorial Designs

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Abstract

Multi-stratum factorial designs, such as block designs and row–column designs, are widely used for screening treatment factors in experiments with complex experimental-unit structures arising from multiple sources of variability. In this presentation, I will introduce a unified, model-free approach—termed orthogonalized moment aberration—for comparing similarities among level combinations of treatment factors assigned to heterogeneous experimental units. The proposed approach evaluates the rows of design matrices through kernel functions, rather than the columns, enabling the assessment of a broad class of mixed-level regular and nonregular factorial designs under heterogeneous experimental-unit structures known as partially relaxed orthogonal block structures. This framework is highly flexible: different choices of kernel functions allow adaptation to various experimental scenarios, with certain choices recovering well-known minimum aberration criteria from the literature. Although model-free in nature, the proposed method admits rigorous justification via linear mixed-effects models and Gaussian process models. Theoretical results and numerical examples demonstrate that this approach can generate multi-stratum factorial designs with high Bayesian D-efficiencies.

Keywords: Block design; Minimum aberration; Minimum moment aberration; Orthogonal array; Split-plot design