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# Robust D-Optimal Designs for Ordinal Split-Plot Experiments via Surrogate Objective Functions

In industrial split-plot experiments, traditional algebraic block generators often force complete aliasing between critical sub-plot interactions and whole-plot blocks, trapping vulnerable effects within the high-variance whole-plot error stratum and severely reducing experimental power. While algorithmic D-optimal designs can mitigate this loss through partial confounding, generating such designs for ordinal responses has remained computationally intractable. Evaluating the exact Fisher Information Matrix (FIM) requires an O(K^n) combinatorial enumeration, further compounded by an O(2^n) dimensional penalty in exact Archimedean copula models. To address this structural limitation, we propose two efficient surrogate objective functions: a conditional GLMM surrogate that collapses the expected FIM into localized univariate expectations, and a Pairwise Composite Likelihood (PCL) copula surrogate that restricts the dependence structure to bivariate components. These surrogates reduce computational burden by several orders of magnitude while recovering designs that are identical or nearly identical to those obtained under exact evaluation. This enables the construction of parameter-robust split-plot designs that avoid sacrificing critical interactions to the whole-plot stratum, providing a computationally tractable approach for generating structurally robust, precision-efficient experiments.

## Special/ Invited session

## Classification

Both methodology and application

## Keywords

Ordinal data, Restricted randomization, D-Optimal designs

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