Optimal Exact Designs of Multiresponse Experiments under Linear and Sparsity Constraints

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We propose a computational approach to constructing exact designs on finite design spaces that are optimal for multiresponse regression experiments under a combination of the standard linear and specific sparsity constraints. Linear constraints can represent, for example, limits on the total cost or protected/augemented experimental trials. Importantly, the sparsity constraints are nonlinear in the design weights and make it possible to optimize over exact designs with structural requirements that are not directly expressible by ordinary linear restrictions, such as a prescribed number of support points, or replication bounds applied only to the support points of the design. The main idea is to transform the constrained multiresponse problem into an auxiliary univariate-response optimal design problem with only linear constraints, allowing existing mathematical-programming tools to be used. We illustrate the method on a dose-finding study, where it is necessary to balance several competing practical and ethical requirements: it should provide enough information to estimate the dose-response relationship, avoid assigning too many patients to ineffective or toxic doses, respect budgetary limitations, and include a clinically meaningful number and spacing of dose levels. The presented example is a Phase I/II setting where efficacy and toxicity are modelled jointly by a continuation-ratio model, leading to a trinomial response at each dose, in which sequentially adding constraints on safety, cost, support size, dose spacing, and allocation balance yields a directly implementable design for 100 patients.

References

[1] Filová, L., Somogyi, P., Harman, R. (2026). Optimal Exact Designs of Multiresponse Experiments Under Linear and Sparsity Constraints. Applied Stochastic Models in Business and Industry, 42(2).