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GROUPED ORTHOGONAL ARRAYS AND THEIR CONSTRUCTION METHODS

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Abstract: In computer experiments, it has become a standard practice to select the inputs that spread out as uniformly as possible over the design space. The resulting designs are called space-filling designs and they are undoubtedly desirable choices when there is no prior knowledge on how the input variables affect the response and the objective of experiments is global fitting. When there is some prior knowledge on the underlying true function of the system or what statistical models are more appropriate, a natural question is, are there more suitable designs than vanilla space-filling designs? In this article, we provide an answer for the cases where there are no interactions between the factors from disjoint groups of variables. In other words, we consider the design issue when the underlying functional form of the system or the statistical model to be used is additive where each component depends on one group of variables from a set of disjoint groups. For such cases, we recommend using *grouped orthogonal arrays.* Several construction methods are provided and many designs are tabulated for practical use. Compared with existing techniques in the literature, our construction methods can generate many more designs with flexible run sizes and better within-group projection properties for any prime power number of levels.

Key words and phrases: Additive model, computer experiment, design of variable resolution, fractional factorial design, group kernel, space-filling design, uncertainty quantification.

1. Introduction

Space-filling designs are ubiquitous in the practice of computer experiments and the research community (Santner, Williams and Notz, 2018; Gramacy, 2020). These designs are used for selecting the settings of input variables to explore how responses depend on input variables, by scattering the points in the design region as uniformly as possible. In practice, if there is no preference or knowledge on the choice of statistical models, a statistically sound way is to collect data from all portions of the design region, that is, to use space-filling designs to entertain flexible statistical models (also called surrogate models or emulators in computer experiments). This idea can trace back to as early as Box and Draper (1959), who introduced a basis for the selection of a response surface design, to the best

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