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ORTHOGONAL MINIMALLY ALIASED RESPONSE SURFACE DESIGNS FOR THREE-LEVEL QUANTITATIVE FACTORS AND TWO-LEVEL CATEGORICAL FACTORS

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Abstract: Orthogonal minimally aliased response surface (OMARS) designs constitute a new family of three-level experimental designs for studying quantitative factors. Many experiments, however, also involve one or more two-level categorical factors. In this work, we derive necessary conditions for the existence of mixed-level OMARS designs, and present three construction methods based on integer programming. Like the original three-level OMARS designs, the new mixed-level designs are orthogonal main-effect plans in which the main effects are also orthogonal to the second-order effects. These properties distinguish the new designs from definitive screening designs with additional two-level categorical factors and other mixed-level designs recently presented in the literature. To demonstrate the flexibility of our construction methods, we provide 587 mixed-level OMARS designs in the online Supplementary Material.

Key words and phrases: Definitive screening design, foldover design, mixed integer programming, OMARS design, orthogonal array.

1. Introduction

The dominant experimental designs in process optimization and response surface modeling, where all experimental factors are quantitative, have long been central composite designs (Box and Wilson (1951)), small central composite designs (Hartley (1959)), and Box–Behnken designs (Box and Behnken (1960)). With the introduction of exchange algorithms in the last few decades of the previous century, response surface experiments using optimal experimental designs (Goos and Jones (2011)) gained substantial popularity as well. More recently, many experimenters have switched to definitive screening designs (DSDs, see Jones and Nachtsheim (2011); Xiao, Lin and Bai (2012)), because these designs allow the study of many quantitative factors using a limited number of experimental runs. However, these response surface designs all possess certain weak-

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