

## TWO-LEVEL ISOMORPHIC FOLDOVERS DESIGNS

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*Abstract:* Two-level orthogonal arrays ensure the independent estimations of main effects when linear models are considered, and thus are popularly used experimental designs. Such arrays can be classified into regular and nonregular designs (Wu and Hamada, 2021). Regular designs entertain specific algebraic structures and thus have been well studied in the literature. Their run sizes, however, are limited to powers of 2. Nonregular designs have a more complicated structure, but they are more flexible in the run sizes and allow the estimation of more effects. The construction of nonregular designs remains a challenge. This paper introduces a new class of nonregular designs called isomorphic foldovers design (IFD). Specifically, it is composed of several foldovers of an initial design. The goal of our study is to investigate the general theory of IFDs. We propose a method for obtaining all nonequivalent IFDs with  $f$  foldovers for any initial design. Two algorithms are provided to construct optimal  $f$ -IFD in terms of  $G$ -aberration (or  $G_2$ -aberration) criterion. The IFD structure provides an efficient way to find good designs in the sense that constructing good IFDs based on a nonregular initial design is often more successful than doing so with a more granular single flat. Meanwhile, the IFDs have a parallel flats structure and thus are much easier to understand and analyze than many other nonregular designs. Moreover, we show that some existing designs can be viewed as special cases of IFDs.

*Key words and phrases:* Foldover,  $G$ -aberration criterion, nonregular design, screening experiment.

### 1. Introduction

Two-level orthogonal arrays can be roughly classified into regular and nonregular designs according to the aliasing structure (Wu and Hamada, 2021). The estimated effects of a regular design are either orthogonal or fully aliased. Their run sizes are limited to a power of 2. Two-level regular designs have been well studied and enumerated; see Box and Hunter (1961), Draper and Mitchell (1967), Chen and Lin (1991), Chen, Sun and Wu (1993), Mee (2009), Xu (2009), Shrivastava and Ding (2010), Liu, Yang and Liu (2011), Wu and Hamada (2021), and the references therein. In contrast, the estimated effects in a nonregular design can be partially confounded. Compared with regular designs, they have a more complicated aliasing structure but more flexible run sizes (a multiple of 4). In addition, nonregular designs allow for estimating more effects.

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