Construction of Efficient Fractional Factorial Designs for General Factorials under a Baseline Parametrization

Rahul Mukerjee*
Indian Institute of Management Calcutta, Kolkata, India
rmuk0902@gmail.com

Fractional factorial designs have wide ranging applications in such diverse fields as industry, agriculture, medicine and so on. The existing literature on these designs revolves around the well-known orthogonal parametrization and orthogonal arrays play a key role in the construction of optimal fractions. In recent years, however, another kind of parametrization, namely, the baseline parametrization, has started gaining popularity in the context of factorial experiments. This parametrization has its roots in cDNA microarray experiments but can arise naturally in many other situations whenever each factor has a control or baseline level. The task of finding optimal or efficient fractions under the baseline parametrization is, however, quite challenging – for example, under this parametrization, designs given by orthogonal arrays do not remain optimal beyond the case where each factor has two levels and all interactions are absent. As a result, the combinatorics underlying efficient designing of such fractions become rather complex for general factorials. The present article aims at addressing this problem. With a view to obtaining highly efficient fractions for general factorials with an arbitrary number of levels for each factor, we begin by employing the approximate theory based on directional derivatives. The underlying model is kept quite flexible – it includes the baseline effect, all main effects and selected user specified interactions. Somewhat counter intuitively, even after the use of the approximate theory, it is seen that a naïve discretization of the resulting optimal design measure, via rounding off to nearest integers, often fails to ensure high efficiency of the resulting designs in the practically important case where the run size is relatively small. To circumvent this difficulty, we propose supplementing the approximate theory by a step-down procedure which is found to work very well in producing highly efficient fractions for general factorials. Several illustrative examples are given.

Key words: Approximate theory, directional derivative, step-down procedure.