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Optimal Asymmetric Fractional Factorial Plans using Finite Projective Geometry

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SUMMARY

Dey *et al.* (2005) obtained universally optimal plans for asymmetric factorial experiments under hierarchical model that includes the mean, all M.E. and a specified set of 2FI, assuming other interactions are negligible. In this paper, we construct two new asymmetric optimal fractional factorial plans under new hierarchical models using finite projective geometry. One of the optimal plans permits the estimability of the mean, all M.E., a specified set of 2FI and a specified set of 3FI. The other plan permits the estimability of the mean, all M.E. and a specified set of 2FI.

We also construct some new asymmetric optimal fractional factorial plans under a hierarchical model for estimation of the mean, all M.E. and a specified set of 2FI.

Key words: Galois field, Finite projective geometry, Universal optimality, Saturated plans.

1 INTRODUCTION

Fractional factorial designs are commonly used in industrial experiments where a large number of factors has to be studied. Optimality of fractional factorial plans has been studied by many researchers in recent years. In practical situation, all factorial effects involving same number of factors may not be equally important. The issue of estimability and optimality in the context of two level factorials has been studied by Hedayat and Pesotan (1992, 1997), Wu and Chen (1992), Chiu and John (1998) and Ke and Tang (2003). Optimality results for arbitrary factorials including asymmetric ones were obtained by Dey and Mukerjee (1999). Dey *et al.* (2005) (we will abbreviate in the remainder as DSD) obtained optimal asymmetrical fractional factorial plans for estimation of the mean, all M.E. and a specified set of 2FI using finite projective geometry. In this paper, we construct two new asymmetric optimal fractional factorial plans under new hierarchical models using finite projective geometry. One of the optimal plans permits the estimability of the mean, all M.E., a specified set of 2FI and a specified set of 3FI. The other plan permits the estimability of the mean, all M.E. and a specified set of 2FI.

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We also construct some new asymmetric optimal fractional factorial plans under a hierarchical model for estimation of the mean, all M.E. and a specified set of 2FI. In Section 2, we give some preliminaries of finite projective geometry.

In Section 3.1, we construct a new optimal fractional factorial plan for an $(m^{u_i}) \times m^{A+B}$ experiment which permits the estimation of the mean, all M.E. a specified set of 2FI and a specified set of 3FI. In Section 3.2, we construct new optimal fractional factorial plans for an $(m^3) \times (m^2) \times m^w$, $w > 1$ experiment which permits the estimation of the mean, all M.E. and a specified set of 2FI. We also construct some new optimal fractional factorial plans for an $(m^d)^e \times (m^g)^h$ experiment which permits the estimation of the mean, all M.E. and a specified set of 2FI in Section 3.3.

2. FINITE PROJECTIVE GEOMETRY

A finite projective geometry of $(r - 1)$ dimension $PG(r - 1, m)$ over $GF(m)$, Galois field of order m, m is a prime power, consists of the ordered set $(x_0, x_1, ..., x_{r-1})$ of points where x_i $(i = 0, 1, ..., r - 1)$ are elements of $GF(m)$ and all of them are not simultaneously zero. For any $\lambda \in GF(m)$ $(\lambda \neq 0)$, the point $(\lambda_0, ..., \lambda_{r-1})$