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CONSTRUCTION OF MAXIMIN DISTANCE LATIN HYPERCUBE DESIGNS VIA GOOD LATTICE POINT SETS

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Abstract: Space-filling Latin hypercube designs have found widespread applications in computer experiments, yet the construction methods for such designs pose significant challenges. Algebraic methods are only applicable to a very limited number of runs and factors, while algorithmic searches often struggle with computational feasibility for large designs, especially when there is a need to maintain the statistical efficiency above a certain level. To address these limitations, an approach is proposed for producing space-filling Latin hypercube designs that can accommodate flexible numbers of runs and factors. The proposed approach is hybrid in nature, incorporating an algebraic method and its corresponding algorithm. The algebraic method, built on good lattice point sets and level permutation techniques, applies to any run size and flexible numbers of factors. The proposed algorithmic search can further accommodate any number of factors, especially those not covered by the algebraic method. A theoretical analysis of optimality is provided for the algebraic component. Numerical studies demonstrate the superior L_p-distance properties of the proposed designs. Furthermore, it is shown that the proposed designs exhibit good column-orthogonality and projection uniformity as well.

Key words and phrases: Column-orthogonality, computer experiment, level permutation, projection uniformity, space-filling design.

1. Introduction

Space-filling designs are widely utilized in computer experiments, such as Latin hypercube design (LHD) proposed by McKay, Beckman and Conover (1979) and uniform design (Fang and Wang, 1981). It aims to select experimental runs that efficiently cover the entire design space. Various criteria have been proposed to assess space-filling properties, such as the uniformity criterion (Weyl, 1916; Zhou, Fang and Ning, 2013), maximin distance criterion (Johnson, Moore and Ylvisaker, 1990), column-orthogonality (Owen, 1994), ϕ_p criterion (Joseph and Hung, 2008), projection uniformity (Moon, Dean and Santner, 2011) and minimum aberration type criterion (Tian and Xu, 2022). Among them, the maximin distance criterion, which maximizes the minimum pairwise distance

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