A Layer-by-layer Point Design Algorithm in High-dimension Space based on the Good Lattice Point Method

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April 17, 2023

Abstract

Good lattice point (GLP) sets are many of points uniformly distributed over the domain of interest and thus have good space-filling property. GLP sets are frequently used in many applications, such as quasi-Monte Carlo, dimensional integral, structural reliability evaluation and other areas. However, as the number of dimensions and points increases, the amount of calculation of GLP sets also increases and could not get a better generating vector to obtain the good point sets especially in high-dimensional space. To handle this problem, a new method is proposed for GLP sets in high-dimensional space, which has a great advantage and low-discrepancy compared with existing GLP method. Firstly, changing the generating vector of GLP sets based on the existing theories and making it more suitable high-dimensional space. Secondly, selecting a prime p as the number of points and getting all of primitive roots of p. Then, the phenomenon of the same discrepancy in the set of points produced by different primitive root is theoretically derived, to reduce the range of primitive roots and obtaining the point sets for each primitive root in the new range. Next, substituting the primitive roots in new range into the proposed method and getting point set. Finally, viewing discrepancy as an index, the point set with the lowest discrepancy is selected as the GLP set in the high-dimensional space. Two numerical examples are studied to validate the proposed method, the first numerical example indicates that the proposed method is of low-discrepancy and efficiency for high-dimensional GLP sets; The second numerical example shows that the point set generated by the method proposed in this paper is suitable for solving fatigue reliability evaluation of stayed cables and the results are consistent with the accuracy of Monte Carlo simulation.

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