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Space-partition method for the variance-based sensitivity analysis: optimal partition scheme and comparative study

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Abstract: Variance-based sensitivity analysis has been widely studied and asserted itself among practitioners. Monte Carlo simulation methods are well developed in the calculation of variance-based sensitivity indices but they do not make full use of each model run. Recently, several works mentioned a scatter-plot partitioning method to estimate the variance-based sensitivity indices from given data, where a single bunch of samples is sufficient to estimate all the sensitivity indices. This paper focuses on this space-partition method in the estimation of variance-based sensitivity indices, and its convergence and other performances are investigated. Since the method heavily depends on the partition scheme, the influence of the partition scheme is discussed and the optimal partition scheme is proposed based on the minimized estimator's variance. A decomposition and integration procedure is proposed to improve the estimation quality for high order sensitivity indices. The proposed space-partition method is compared with the more traditional method and test cases show that it outperforms the traditional one.

Keywords: Global sensitivity analysis; variance-based sensitivity indices; sample space partition; minimized estimation variance; Monte Carlo sampling

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