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A new high-order polynomial surrogate model using sequential sampling method

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Abstract

To avoid routine tasks of expensive computer simulations in engineering, the surrogate models have been widely used. This paper will propose a high-order polynomial surrogate model (HOPSM) that includes two novel aspects compared to conventional approximation of functions in high dimension, with a view to retaining advantages of low-order polynomial models in efficiency, transparency and simplicity while overcoming their disadvantage in accuracy. In constructing HOPSM, firstly, the zeros of Chebyshev polynomials with the highest allowable order will be used as sampling candidates to improve stability and accuracy. An incremental sampling scheme using the *maximin* principle is developed to collect sampling points from the set of all candidates, with a space-filling scheme generating the initial samples. Secondly, the order of HOPSM is updated through an order incremental method, which will adaptively improve the order of the polynomial sequentially with the increase of the sampling size. The final HOPSM after the order increment will be determined as the polynomial that has the largest adjusted R-square. The HOPSM is compared with the well-known Kriging and RBF surrogate models using both test functions and two engineering applications, to demonstrate accuracy and robustness of the proposed method.