Sequences of Nested Space-Filling Designs, Multi-Scale Methods for Improving Interpolators, and Perturbable Models for Temperature Control Systems

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Abstract

Part 1: An approach to constructing sequences of nested space-filling designs (NSFDs) based on (t, s)-sequences is proposed. The method is simple, easy to implement, and quite general. For continuous factors, this approach produces NSFDs with the best possible space-filling properties. Unlike existing procedures, this method can produce NSFDs for categorical and mixed factors. Several important applications of the constructed designs are discussed. **Part 2:** A simple multi-scale approach to improving the accuracy of interpolators is presented. This approach is very useful for sequential input selection and modeling of computer experiments. In many situations, an interpolator's nominal and numeric accuracies are controlled by the dispersion and separation distance of the input sites, respectively. The multi-scale approach allows the nominal and numeric properties to be handled separately. Several illustrations are given. **Part 3:** A statistical framework is proposed within which the behavior of a large cooling system can be modeled and forecast under both steady state and perturbations. This framework is based upon an extension of multivariate Gaussian autoregressive hidden Markov models (HMMs). The proposed model is fit to data from a group of air conditioners within a data center from the IT industry. The fitted model is examined and a particular unit is found to be under-utilized. Predictions are generated for the system under the removal of that unit.