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Abstract

An optimal balance between explorations and repetitions in sensitivity analysis

Sensitivity analysis is well developed for deterministic computer models. When the computer model is stochastic, however, it is less clear what its performance is, or even what it means. Typically, the computer model is repeated several times, say m, at each one of the explorations of the input space, leading to a number of runs proportional to mn, where n is the number of explorations. How does the performance of the estimators depend on (n,m)? What is the definition of a Sobol index for stochastic models? Our contribution is twofold. First, we build a formalism in which two definitions of Sobol's indices are given, estimators are built and asymptotic properties are established in terms of both n and m, revealing the differences between the two kinds of sensitivity indices. Second, we address the problem of choosing an optimal balance between repetitions and explorations under a fixed budget constraint. We define the optimal number of repetition as the couple (n,m) that minimizes the risk of a bad ranking of the input factors. We proceed by designing a two-step procedure in which the first step serves to estimate the optimal number of repetitions and the second step the sensitivity indices based on the number found in the first step. We show that this procedure is asymptotically oracle, in the sense that it does arbitrarily as good as the procedure in which the optimal number of repetitions is known. Numerical illustrations are provided to illustrate our theoretical findings.