Design and analysis of experiments with simulation models:
Classic and novel methods for sensitivity analysis

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ABSTRACT

To improve the quality of predictions coming from computer simulation models, sensitivity analysis (SA) is needed. By definition, SA examines the variation in the model's output -- due to variation in its inputs. An unscientific choice of input variation implies a suboptimal SA! Unfortunately, many scientists and practitioners change only one input at a time in their SA, whereas the statistical theory on Design of Experiments (DOE) proves that such a choice is inferior.

DOE started in the 1930s with agricultural experiments. Since the (say) 1970s, classic designs (such as fractional factorials) have also been applied to experiments with simulation models – both random and deterministic models; see Kleijnen (1974/1975).

Since the 1980s, novel designs have been developed for deterministic simulation models; see Sacks et al. (1989) and Koehler and Owen (1996). These novel designs select input combinations that differ substantially from classic designs. The concomitant analysis of the resulting input/output (I/O) also uses very different (meta)models, e.g., Kriging models instead of low-order polynomials.

Recently Kleijnen and Van Beers (2003) applied these designs and their analysis to random simulation models.

In conclusion, the choice of an appropriate design and its concomitant analysis (through an adequate metamodel) require a new way of looking at simulation experiments. For example, metamodels of different complexity require different designs. And simulation proceeds sequentially, so designs should also be made sequential. Finally, simulation experiments may involve hundreds of inputs. See Kleijnen et al. (2003).

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