Metamodel Uncertainty in Simulation-Optimization: a Bootstrap Analysis

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Metamodels are often used in simulation-optimization studies devoted to the design and management of complex systems enabling the integration of discipline-dependent analysis into the overall decision or optimization process. These metamodels yield insight into the relationship between responses and decision variables, providing fast analysis tools in place of the more expensive computer simulations. The combined use of stochastic simulation experiments and metamodels introduces a source of uncertainty in the decision process that we refer to as metamodel variability. To quantify this variability, we propose a novel approach, combining validation and bootstrapping techniques. The rationale behind the method relies on the fact that, after the validation process, the validation (relative) errors are acceptably small; i.e., the metamodel provides an approximation considered to be appropriate by the decision maker. Therefore, bootstrapping these errors allows to quantify the metamodel variability in an acceptable way. The resulting methodology is illustrated through some examples using regression and Kriging metamodels. As opposed to other classical methods, our approach has proven to be applicable to different kind of metamodels and validation techniques, without any restricting assumptions or prior knowledge required on the metamodel's parameters. Further, it is not computationally expensive, so it can be used when time constraints hold for the system under investigation.