

Robust optimization using computer experiments

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The goal of many experiments is to estimate the best solution for a given practical problem. Such experiments may be conducted with a physical system (e.g., an airplane model in a wind tunnel) or a mathematical model of a physical system (e.g., a computerized simulation model of an airplane or an inventory management system). These experiments produce data on the outputs and the inputs. Output may be univariate (a single or scalar response) or multivariate (multiple responses). The number of inputs may range from a single input to many inputs. The inputs may be controllable or uncontrollable (also called environmental inputs).

Robust Parameter Design (RPD) developed in statistical quality control use metamodels (such as regression, Kriging, etc.) estimated from experiments with both controllable and environmental inputs. RPD assumes known mean and covariance, and sometimes even a known distribution of the environmental inputs. In practice such a distribution is often not known, and the final solution may be very sensitive to estimates for the mean and covariance.

We describe a new approach for RPD that uses only experimental data, so it does not need such assumptions. This new approach uses techniques from Robust Optimization, which is a relatively new and important field in mathematical optimization. We show that this new method can be used for many classes of metamodels, including polynomials obtained via regression and Kriging models. Moreover, we describe an adjustable RPD approach in which the values of (some of) the controllable factors are adjusted after observing the values of (some of) the environmental inputs. This new method is based on Adjustable Robust Optimization techniques. We illustrate our novel method through several numerical examples, which demonstrate its effectiveness.

This is joint work with Jack P.C. Kleijnen and Ihsan Yanikoglu, both from Tilburg University.

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