Sampling based sensitivity analysis: a case study in aerospace engineering

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*Michael Oberguggenberger** (Univ. Innsbruck), *Christoph Aichinger* (Univ. Innsbruck), *Helene Roth* (Univ. Innsbruck), *Katharina Riedinger* (Univ. Innsbruck)

Sensitivity analysis of engineering structures is an important ingredient in the process of assessing their robustness and safety. Usually, the structure is described by means of a large finite element model. In such a case, sampling based sensitivity analysis offers a workable approach. In the past years, we developed a pool of Monte Carlo methods for sensitivity analysis [1]. The methods are based on artificial random variations of the decisive input and shape parameters and a statistical evaluation of the effects on the outputs.

We are currently engaged in a research project that aims at improving computational efficiency and widening the scope of the stochastic models for the parameter variations. This research project ACOSTA (Advanced Concept for Structure Analysis of large light weight structures) is carried out jointly with Intales GmbH Engineering Solutions and two departments at the University of Innsbruck (Mathematics, Civil Engineering), supported by the Austrian Research Promotion Agency. The project focuses on the buckling behavior of the frontskirt of the ARIANE 5 launcher under various loading and flight scenarios.

This presentation addresses a new approach combining Monte Carlo simulation methods with iterative solvers. This aims at saving a significant amount of computing time by performing a load incremental procedure with an initial set of input parameters and starting the random variations at a later time, when a larger percentage of the ultimate load is reached.

A second development concerns correlated variables in sensitivity analysis. We indicate how spatial random variations of parameters across the structures can be modeled by random fields and how this contributes to a more complete sensitivity analysis.

[1] M. OBERGUGGENBERGER, J. KING, B. SCHMELZER: Classical and imprecise probability methods for sensitivity analysis in engineering: A case study. *International Journal of Approximate Reasoning* **50** (2009) 680–693.