Imprecise probabilities for dealing with decisional challenges in performance-based engineering

Marco de Angelis, **Edoardo Patelli**, and **Michael Beer**

Inst. for Risk and Uncertainty, School of Eng., University of Liverpool
Liverpool L69 3GQ, UK, marco.de-angelis@liverpool.ac.uk

Keywords: *Imprecise Probability; Reliability; Advanced Monte Carlo Simulation.*

Abstract

A rational way to deal with decisional challenges consists in making the least amount of assumptions. This applies because, most often, only few data are available and it is not possible to create a definite map of values for the inputs of the computational model; see Augusti and Ciampoli (2008). Decisional challenges may be sensibly eased by computational models that allow simultaneously assessing several states of the system under design. This is commonly obtained by letting the state variables vary according to probability distributions. However, in doing so, rearrangements of the variables' values are dictated by specific probability distributions, which choice is commonly made based on very weak evidence. The general framework of imprecise probability provides the answer to the decisional challenges posed by the design of structural systems; see Beer, Ferson and Kreinovich (2013). In fact, it allows not choosing a definite distributional model and, therefore, provides enough room for making rational decisions. Operating with imprecise probability means assessing several states of the system within a whole set of probability distribution functions, thus, it allows relaxing the assumption over a definite distributional model. In this paper a general numerical framework is presented for constructing computer models capable of processing inputs defined as a set of probability distribution functions. The framework implements a numerical solution strategy that couples advanced simulation methods and optimization procedures, and provides a credible tool for calculating imprecise measure of probability. The tool is integrated in the open source general purpose software OpenCossan; see Patelli and Schuëller (2012). It is shown by means of examples, that the numerical tool is quite efficient and particularly accurate in assessing the vulnerability of linear systems with no restrictions in terms of dimensions.

References

Augusti, G. and M. Ciampoli Performance-based design in risk assessment and reduction. *Probabilistic Engineering Mechanics*, 2008.

Beer, M. and S. Ferson and V. Kreinovich Imprecise probabilities in engineering analyses. *Mechanical Systems and Signal Processing*, 2013.

Patelli, E. and M. Panayirci, and Broggi, M. and Goller, B. and Beaurepaire, P. and Pradlwarter, H. J. and Schuëller, G. I. General purpose software for efficient uncertainty management of large finite element models. *Finite Elements in Analysis and Design*, 2012.