A generalised framework for aleatory and epistemic uncertainties propagation using random set theory

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ABSTRACT

In the context of uncertainty propagation, the input parameters of a computational model might be described with different uncertainty models, such as random variable, interval variable, Dempster-Shafer theory of evidence, possibility theory, and set of probability distributions, as well as their combinations. This work aims at developing a generalised uncertainty propagation framework that can deal with those uncertainty descriptions. Toward this end we use random set models, i.e. set-valued random variables, as the common description. Indeed, the above listed uncertainty models can be equivalently represented using random sets.

A direct evaluation of the random set of quantities of interest (Q.o.I) might be impractical as the computation model could require a large computational resource. To reduce computational cost, the Q.o.I random set is approximated using a random discrete set whose domain is the set of samples generated using a proposed probability distribution. In this work the capacity transform density function for this proposed distribution. With such approximation method, the computational burden is comparable with the uncertainty propagation problem in the probabilistic framework. To further reduce computational cost, a surrogate model using polynomial chaos expansion is constructed.

REFERENCES