Local Reliability Based Sensitivity Analysis with the Moving Particles Method

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Abstract

Reliability based sensitivity analysis investigates the dependence of the failure probability on model parameters. In this study, the relevant model parameters are distribution parameters related to the probabilistic characterization of the model input. For sensitivity analysis, local and global approaches can be distinguished. Local reliability sensitivity methods compute the partial derivatives of the failure probability or the reliability index with respect to model parameters. Global reliability sensitivity analysis aims at determining the influence of a model parameter on the failure probability over the entire range of possible values for this parameter. It is often based on Sobol indices.

In this presentation, local reliability based sensitivity analysis is considered and the reliability analysis is carried out by the moving particles method, see Walter (2015), where a threshold is associated to each sample, samples are moved to new positions in the design space and the number of moves for the initial samples (the particles) to reach the failure region are counted and yield an estimator for the failure probability, which is based on a Poisson process. The estimator is of comparable accuracy and efficiency as the subset simulation estimator. For local reliability based sensitivity analysis, it is important to avoid repeated evaluations of the limit state function. To this end, an extension of the moving particles method to local reliability based sensitivity analysis is presented that is completely based on the already evaluated samples for the reliability estimate and thus avoids repeated evaluations of the limit state function. The method is discussed in detail and illustrated by means of examples.

References

Walter, C. Moving Particles: A Parallel Optimal Multilevel Splitting Method with Application in Quantiles Estimation and Meta-Model Based Algorithms. *Structural Safety*, 55:10–25, 2015.