Engineering Risk Analysis Group
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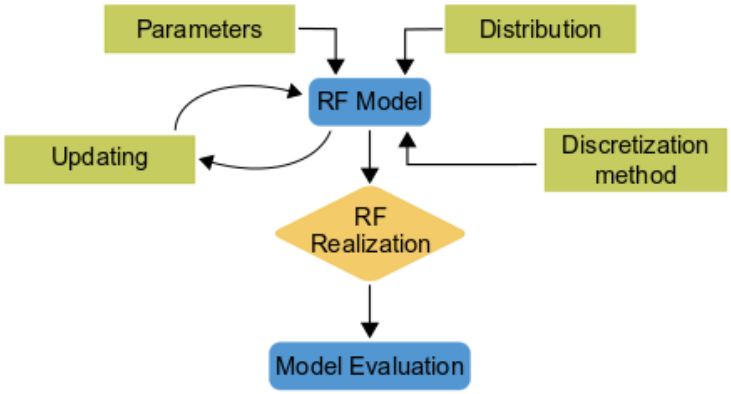
MSc thesis

Visualization of Random Fields and Their Influence on Modeling Uncertainties in Reliability Analysis

Melina Rohne, May 2019

Background

This thesis deals with the poor comprehension of random fields and their problems and explains this topic in a more visual and exemplary way. An evaluation of a questionnaire done in class points out the problems of understanding the random field approach. Based on this, a flowchart (shown below) that shows the different parameters that need to be set to categorize a random field model, is developed and extended throughout this thesis.



Process of generating a random field with all its parameters and adjustments explained in this thesis.

Methodology

The thesis is structured as follows: First, the random field approach is presented, and the components to set up a random field model are explained individually and set in context. In particular, this thesis focuses on three discretization methods, the midpoint method, the spatial averaging method and the Karhunen-Loève expansion. Their accuracy is evaluated using the mean square error. Further, the process of updating a random field model is introduced. Next, problems of understanding are discussed. In the second main part these methods and parameters are visualized within a one-dimensional Bernoulli beam and a groundwater flow in a two-dimensional surrounding.

Conclusion

The goal is to create an acceptance of the usage of random fields by a visual explanation. In future software these methods can be implemented for calculations and reliability analysis. Therefore, a SWOT analysis analyzes the implementation of random fields within a commercial software. The computational possibilities and the demand for complex software solutions form the main possibilities for this method, however a user acceptance needs to be achieved using a clear way of transmitting the positive usage of random fields. Obtaining this acceptance through a visual representation of random fields is the focus of this thesis.

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