Engineering Risk Analysis Group
Prof. Dr Daniel Straub

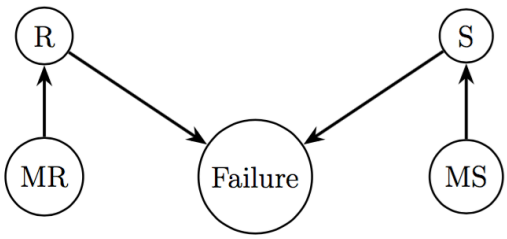
Master's Thesis – Computational Science and Engineering

Updating of small probabilities using hybrid Bayesian networks

Zhibin Cheng, January 2017

Background

In the field of structural reliability, Bayesian networks (BNs) are applicable to calculate the probability of a rare event (e.g. small failure) when new information becomes available. Often structural reliability problems can be typically described as a function with a set of input variables through a physical model (e.g. a FE model or an analytical expression), where the input variables can be either discrete or continuous random variables. Usually in an engineering system, those input variables are continuous rather than discrete. However, for general BNs, which consist of continuous and discrete random variables (the so-called hybrid BNs), it is not possible to proceed the exact inference. Consequently, approximate inference algorithms have been proposed and implemented in software.



An graphical representation of 2 dimensional problem in BN, where R,S are capacity and demand respectively with their measurement nodes

Methodology

Through the literature review, using different approaches to handle the hybrid BNs in the field of structure reliability are discussed. The performance of some existing software tools in terms of accuracy and computational effort on several benchmark problems, which the solutions can be calculated analytically, is evaluated. In the thesis we investigate the following available software tool, AgenaRisk, OpenBugs, UniNet and the efficient discretization tool developed by ERA group at TUM is evaluated.

Results

One approach is more feasible than the others under a certain circumstance. The efficient discretization tool and AgenaRisk are influenced by the dimensions of the given problems. OpenBugs is able to yield satisfactory results if the number of samples is sufficient. UniNet can complete the whole task with little computational time, but its accuracy need to be improved.

Supervised by M.Sc. Kilian Zwirglmaier, Prof. Dr. Daniel Straub (TUM),