A 2-dimension dynamic Bayesian network for large-scale degradation modelling with an application to a bridges network

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Résumé en anglais	Modeling the stochastic evolution of a large-scale fleet or network generally proves to be challenging. This difficulty may be compounded through complex relationships between various assets in the network. Although a great number of probabilistic graph-based models (e.g., Bayesian networks) have been developed recently to describe the behavior of single assets, one can find significantly fewer approaches addressing a fully integrated network. It is proposed an extension to the standard dynamic Bayesian network (DBN) by introducing an additional dimension for multiple elements. These elements are then linked through a set of covariates that translate the probabilistic dependencies. A Markov chain is utilized to model the elements and develop a distribution-free mathematical framework to parameterize the transition probabilities without previous data. This is achieved by borrowing from Cooke's method for structured expert judgment and also applied to the quantification of the covariate relationships. Some metrics are also presented for evaluating the sensitivity of information inserted into the covariate DBN where the focus is given on two specific types of configurations. The model is applied to a real-world example of steel bridge network in the Netherlands. Numerical examples highlight the inference mechanism and show the sensitivity of information inserted in various ways. It is shown that information is most valuable very early and decreases substantially over time. Resulting observations entail the reduction of inference combinations and by extension a computational gain to select the most sensitive pieces of information.
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