Bayesian Network Modeling for Efficient Inference in SHM

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Keywords: Bayesian Network, Junction Tree Algorithm, Importance Sampling.

【Introduction】

A key challenge in structural health monitoring (SHM) is managing epistemic and aleatory uncertainties and improving computational efficiency for real-time analysis. This study uses probabilistic theory and Bayesian methods to quantify uncertainties in SHM, focusing on damage severity estimation while considering measurement noise, environmental factors, and multi-damage effects.

【Objective】

The research aims to develop a Bayesian network model for damage assessment, incorporating feature variables (FVs), damage variables (DVs), and environmental and operational variables (EOVs), and dependencies among these variables. The model seeks to provide a robust framework for uncertainty quantification.

【Outcome】

The proposed model employs the Junction Tree Algorithm with Importance Sampling (JT-IS) to efficiently handle multi-variable Bayesian inference. This approach enables accurate and computationally efficient processing of multi-dimensional data inputs and damage outputs. The results demonstrate the model's potential for real-time SHM applications, offering a significant improvement in damage detection and severity estimation under complex operational conditions.

【Publication plan】

- BN Modeling for Damage Severity Estimation of Stay Cables in Cable-stayed Bridges.
- Dynamic Bayesian Network (DBN) for SHM of Stay Cables using Time-varying Data.

【Results】

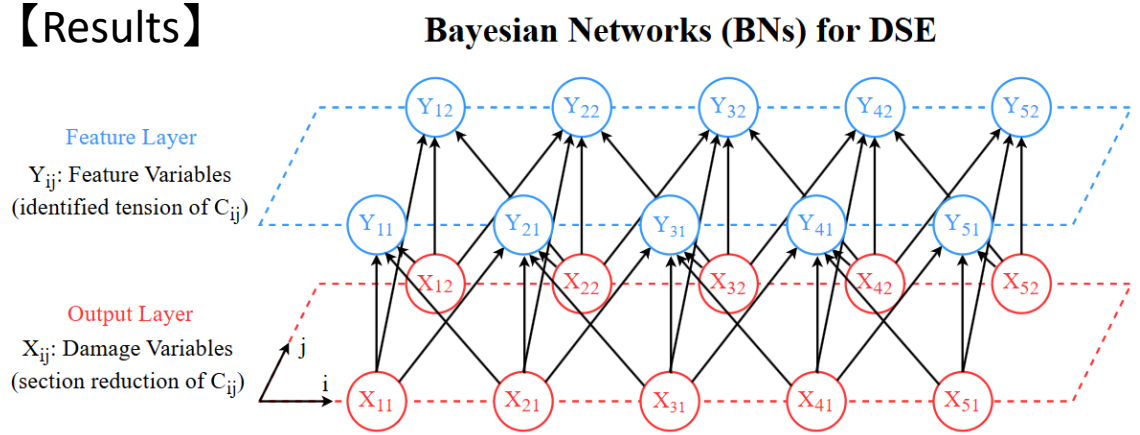

Fig.1. Bayesian Network modeling for feature variables and damage variables.

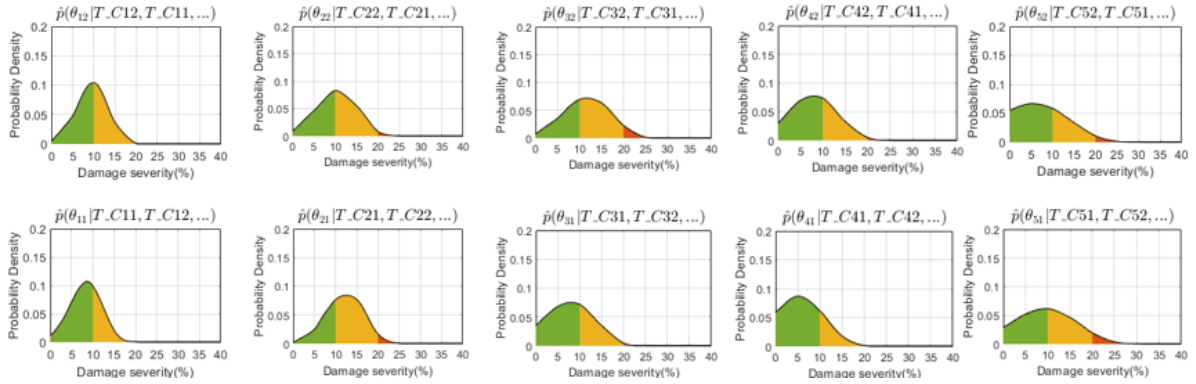

Fig.1. Damage posterior of ten stay cables given a group of input data.