

Sequential Bayesian learning of structural deterioration using monitoring data

Background

Structures and infrastructure systems are subjected to adverse operational conditions, aging and deterioration throughout their lifecycle. Today structural health monitoring (SHM) systems enable measurements of structural response and provide information on the state of structures and infrastructures, their performance and the demands they are subjected to.

Structural deterioration can be seen e.g. in the form of fatigue of mechanical components or corrosion, and a model which describes the deterioration needs to be established (e.g. fatigue crack growth model). The deterioration is a random process over time, and the assumed model contains random parameters. A monitoring system (sensors) deployed on the structure provides continuously dynamic response data. The challenge which arises is to infer the deterioration state (e.g. crack depth), which is not directly observable, as well as to update the time-invariant deterioration model parameters, on the basis of a sequence of noisy dynamic response measurements provided by the SHM system.

Expectations

- familiarity with the basics of probability theory.
- good mathematical and programming skills (preferably in Python)

Objectives

The student conducting the proposed MSc thesis will learn:

- the main aspects of Bayesian probabilistic modeling.
- How to perform advanced Bayesian computation (Markov Chain Monte Carlo, Sequential Monte Carlo) in a sequential setting.
- How to analyze data obtained from SHM systems.

Methodology

The suggested work flow is as follows:

- A numerical benchmark for continuous monitoring of a deteriorating bridge-type structure will be used, which will provide the SHM data.
- A probabilistic crack growth model will be established to model deterioration.
- Using the SHM data, different methods will be implemented to perform Bayesian inference of the uncertain deterioration state over time, as well as the updating of the time-invariant uncertain deterioration model parameters.
- An academic report with the findings of the thesis will be written.

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