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Variational bayesian inference for structural model update

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Appropriate monitoring of transportation infrastructures (e.g. bridges) is of utmost importance to ensure safe operation conditions. Accurate and reliable assessment of such structures can be achieved through the integration of data from non-destructive testing, advanced modeling and model updating techniques. The Bayesian framework has been widely used for updating engineering and mechanical models, due to its probabilistic description of information, in which the posterior probability distribution reflects the knowledge, over the model parameters of interest, inferred from the data. For most real-life applications, the computation of the true posterior involves integrals that are analytically intractable, therefore the implementation of Bayesian inference requires in practice some approximation methods.

This paper investigates the application of Variational Bayesian Inference for structural model parameter identification and update, based on measurements from a real experimental setup. The Variational Bayesian method circumvents the issue of evaluating intractable integrals by using a factorized approximation of the true posterior (mean field approximation) and by choosing a family of conjugate distributions that facilitates the calculations. Inference in the Variational Bayesian framework is seen as solving an optimization problem with the aim of finding the parameters of the factorized posterior which would minimize its Kullback-Leibler divergence in relation to the exact posterior. The Variational Approach is an efficient alternative to sampling methods, such as Markov Chain Monte Carlo, since the latter's accuracy depends on sampling from the posterior distribution a sufficient amount of times (and therefore requiring an equivalent number of computations of the forward problem, which can be quite expensive). Validation of the method will be performed using data acquired from a test bridge structure.

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