Reanalysis based Approximate Bayesian Computation for Inverse Heat Conduction Problem

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Abstract

Bayesian approach has been widely used in inverse heat conduction problem (IHCP). However, if there exist numerical observations in practical IHCP, the Bayesian likelihood function may be intractable. In this study, to avoid the intractable likelihood function, reanalysis based approximate Bayesian computation (ABC) methods are developed for the IHCP. Compared with other methods, the ABC can evaluate the posteriors without likelihood function via a rejection technique. In order to improve the convergence rate of ABC, an adaptive population Monte Carlo (APMC) method is proposed to evaluate the approximate posteriors. However, the heat conduction forward problem is always time-consuming. Furthermore, a large number of expensive evaluations need to be solved in the ABC-APMC process. The computation might be prohibited. To reduce the computational cost, fast and accurate reanalysis techniques are developed for the IHCP. For the static IHCP, with different boundary conditions, only the right term of the equilibrium equation is modified. However, as for the dynamic IHCP, conduction matrix should be updated iteratively. Therefore, different reanalysis techniques are developed to handle these problems. Finally, the accuracy and efficiency of the suggested methods are verified with several examples.

Keywords: Inverse heat conduction problem (IHCP), Approximate Bayesian computation (ABC), Adaptive population Monte Carlo (APMC), Reanalysis