Model-Order Reduction Using Interval Proper Orthogonal Decomposition

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Abstract

Many natural phenomena can be modeled as ordinary or partial differential equations. A way to find solutions of such equations is to discretize them and to solve the corresponding (possibly) nonlinear large systems of equations; see Li and Chen (2008).

Solving a large nonlinear system of equations is very computationally complex due to several numerical issues, such as high linear algebra cost and large memory requirements. Model-Order Reduction (MOR) has been proposed as a way to overcome the issues associated with large dimensions, the most used approach for doing so being Proper Orthogonal Decomposition (POD); see Schilders and Vorst (2008). The key idea of POD is to reduce a large number of interdependent variables (snapshots) to a much smaller number of uncorrelated variables while retaining as much as possible of the variation in the original variables.

In this work, we show how intervals and constraint solving techniques can be used to compute all the snapshots at once (I-POD); see Granvilliers and Benhamou (2006); Kreinovich and Ceberio (2006); Moore and Kearfott (2009). This new process gives us two advantages over the traditional POD method: 1. handling uncertainty in some parameters or inputs; 2. obtaining an enclosure of all snapshots corresponding to all possible inputs.

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