Data-driven approaches for system identification and reduction

Dimitrios S. Karachalios[1], **Ion Victor Gosea**[1], **and Athanasios C. Antoulas**[1,2,3]

[1]*Max Planck Institute for Dynamics of Complex Technical Systems, Data-Driven System Reduction and Identification (DRI) group, Sandtorstrasse 1, 39106 Magdeburg, Germany.*
[2]*Rice University Houston, 6100 Main St., Houston, TX 77005, USA.*
[3]*Baylor College of Medicine, 1 Baylor Plaza, Houston, TX 77030, USA.*

We discuss different ways of constructing nonlinear models from input-output data. We formally present the model order reduction (MOR) problem and comment on conventional intrusive methods that offer solutions. In this context, having access to the original model's operators usually results in dealing with a large-scale system [1]. Therefore, intrusive MOR techniques provide reduced models capable of capturing the original system's response with high accuracy and accelerating the simulation time for efficient design and control.
When the underlying model is unknown or complicated to construct, non-intrusive methods (i.e., interpolation-based) can provide solutions based purely on data [2]. Typically, non-intrusive methods have two aims. The first aim is to identify an embedded model into the general assumed model structure, and the second aim is to construct a reduced model. We present non-intrusive methods for achieving the above two goals based on the Hankel and Loewner frameworks. Both frameworks can identify linear and nonlinear systems from input-output measurements and provide robust interpretable models [3, 4, 5]. We present challenges in handling different data types (e.g., time and frequency) and challenges related to missing data. Finally, we offer solutions to theoretical benchmarks and real engineering problems.

References

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