ized balanced truncation method that relies on two steps. First, we provide necessary and sufficient conditions such that systems explaining the data have common generalized Gramians. Second, these common generalized Gramians are used to construct projection matrices that allow to characterize a class of reduced-order models via generalized balanced truncation in terms of a lower-dimensional QMI by applying the data reduction concept. Additionally, we present alternative procedures to compute a priori and a posteriori upper bounds with respect to the true system generating the data. Finally, the proposed techniques are il- lustrated by means of application to an example of a system of a cart with a double-pendulum.

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MS315

Enforcing Uniform Stability and Passivity in Data-Driven Multivariate Model Order Reduction

We present a comprehensive framework for data-driven model order reduction of parameterized Linear and Time-Invariant systems, with explicit certification of model stability and dissipativity. These properties are mandatory when representing passive physical systems, unable to generate energy. Lack of these properties makes the models practically useless in any simulation setting in which they are used as components, as in Computer Aided Design of electrical and electronic systems. The proposed approach builds on

- a particular model structure, which casts the transfer function of the model as a ratio of two rational functions, each with constant predefined "basis' poles and parameter-dependent residues;
- a parameterization of the above residues expressed in a Berstein polynomial basis, whose partition of unity and positivity are exploited in the derivation of our main result and algorithms;
- availability of sampled responses in frequency and parameter domain, that are fitted by the model through an iterative reweighted linear Least Squares (LS) process;
- the above LS problems is complemented by an explicit, purely algebraic (finite-size) set of constraints that are sufficient for both uniform stability and uniform dissipativity in the parameter space; these constraints provide the key novelty in this contribution.

The proposed approach is illustrated through several electronic CAD application examples.

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MS315

A Realization-Free Balancing-Related Model Reduction Approach from Frequency Response Data

Balancing-related model order reduction methods guarantee stable reduced-order models, and additionally, a priori error bounds have been derived for them. However, the explicit numerical implementation of such methods is often computationally demanding and it is intrusive; this means that it requires explicit access to the matrices scaling the state variables in the original (full-order) dynamical system. For the classical Balanced Truncation (BT) method, and for a few more recent extensions of it, approximate implementations have been derived, which make the application to the large-scale setting more feasible. For time simulation near steady state or for low-frequency applications, the Singular Perturbation Approximation (SPA) method [Fernando/Nicholson, Internat. J. Control, 1982] is known to have better approximation properties than BT. In this contribution, we derive an approximate implementation of SPA that alleviates the computational burden for computing the reduced-order models and can be applied also for such cases in which explicit access to the original dynamical system is not granted. Only transfer function evaluations are required in our approach. Specifically, we adapt and extend the purely data-driven (approximate) implementation of BT in [Gosea/Gugercin/Beattie, SIAM J. Sci. Comput., 2022] to SPA, which as such is strongly related to the Loewner framework. The performance of our proposed method is illustrated by several numerical results.

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MS315

Least-Squares Parametric Reduced-Order Modeling

In this talk, we consider reduced-order modeling for (parametric) linear time-invariant systems, based on nonlinear least-squares. We show how it is a special case of a more general $\mathcal{L}_2$-optimal parametric reduced-order modeling problem by the choice of a measure space. Based on this, we propose a gradient-based optimization algorithm for finding locally optimal reduced-order models. Then, we discuss its relation to the vector fitting method for least-squares reduced-order modeling of linear time-invariant systems. Furthermore, we present the necessary optimality conditions in the interpolation form, related to interpolatory $\mathcal{H}_2$-optimality conditions. Finally, we demonstrate the results on a number of numerical examples.

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