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Data-Driven Identification and Reduction of Dynamical Systems with the Loewner Framework

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Identifying dynamical systems from measured data is an important step towards accurate modeling and control. Model order reduction (MOR) constitutes a class of methods that can be used to replace large, complex models of dynamical processes with simpler, smaller models. The reduced-order models (ROMs) can be then used for further tasks such as control, design, and simulation. One typical approach for projection-based model reduction for both linear and non-linear dynamical systems is by employing interpolation. Projection-based methods require access to the internal dynamics of the system which is not always available. The aim here is to compute ROMs without having access to the internal dynamics, by means of a realization-independent method. The proposed methodology will fall into the broad category of data-driven approaches.

The method under consideration, which will be referred to as the Loewner framework (LF), was originally introduced by the third author. Based on data, LF identifies state-space models in a direct way. In the original setup, the framework relies on compressing the full data set to extract dominant features and, at the same time, to eliminate the inherent redundancies. In the broader class of nonlinear control systems, the LF has been already extended to certain classes with a special structure such as quadratic or bilinear systems. As an application of the aforementioned method is the well studied Lorenz attractor in comparison with other model learning techniques.

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