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Data-driven Structured Realization

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Abstract

We present a framework for constructing structured realizations of linear dynamical systems having transfer functions of the form $\tilde{C}(\sum_{k=1}^K h_k(s)\tilde{A}_k)^{-1}\tilde{B}$ where h_1, h_2, \dots, h_K are prescribed functions that specify the surmised structure of the model. Our construction is data-driven in the sense that an interpolant is derived entirely from measurements of a transfer function. Our approach extends the Loewner realization framework to a more general system structure that includes second-order (and higher) systems as well as systems with internal delays. Numerical examples demonstrate the advantages of this approach.

Keywords: structured realization, data-driven model reduction, interpolation, delay system, second-order system, moment matching

1. Introduction

2 The simulation of complex physical, chemical, or biological processes is a
 3 standard task in science, engineering, and industry. The dynamics of such
 4 processes are commonly modeled as dynamical systems, which then can be an-
 5 alyzed (often through simulation) for optimization and control. The demand
 6 for higher fidelity models produces as a common consequence ever more com-
 7 plex and larger dynamical systems, whose simulation may require computational
 8 resources that become unmanageably large. This computational cost is often di-
 9 rectly related to the state space dimension of the underlying dynamical system,
 10 thus creating a need for low-dimensional approximations of large-scale models.
 11 Model order reduction (MOR) techniques using rational interpolation methods

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