Ion Victor Gosea

Odjel za matematiku, Sveučilište J. J. Strossmayera u Osijeku

15. prosinca 2022.

Data-driven model reduction of second-order systems based on harnessing the advantages of barycentric forms

Data-driven and reduced-order modeling are essential tools for computing high-fidelity compact dynamical models that approximate real-world physical phenomena. In this work, the data represent frequency response measurements, i.e., samples of the transfer function of the unknown model. Barycentric forms (BaryFs) of rational functions are particularly useful and also numerically stable formats to represent such functions. We develop data-driven structure-preserving modeling frameworks for mechanical systems described by second-order (SO) dynamics. In particular, we propose various modified BaryF variants of the transfer function (that extend the classical forms for TF of first-order systems). These allow easy extraction of the corresponding reduced-order models for various structures. The methods proposed here indeed have connections to the classical Loewner framework (LF) by Mayo and Antoulas, the second-order LF approach by Pontes Duff et al., and the AAA algorithm by Nakatsukasa et al. The mixture of interpolation and least-squares fitting is more typical of the latter methodology. We show that by carefully choosing the interpolation points (e.g., in a greedy manner, inspired by AAA), structured reduced models can be constructed to enforce reliable approximation and to impose certain requirements (dictated by the inherent structures).