STRUCTURE-PRESERVING INTERPOLATORY MODEL REDUCTION FOR LINEAR AND NONLINEAR DYNAMICAL SYSTEMS

Serkan Gugercin
Virginia Tech., Blacksburg, VA, USA
e-mail: gugercin@math.vt.edu

Abstract

Direct numerical simulation of dynamical systems plays a fundamental role in studying a wide range of physical phenomena ranging from heat dissipation in complex microelectronic devices to vibration suppression in large structures, to storm surges before an advancing hurricane. However, the ever increasing need for improved accuracy requires the inclusion of ever more detail in the modeling stage, leading inevitably to ever larger-scale, ever more complex dynamical systems. Simulations in such large-scale settings can be overwhelming and make unmanageably large demands on computational resources, which is the main motivation for *model reduction*. Using the systems-theoretic techniques, model reduction aims to produce a much lower dimensional system whose input/output behavior mimics that of the original as closely as possible. Low dimensionality of the model implies that far less storage and far less evaluation time is required.

In recent years, interpolatory model reduction methods have emerged as effective strategies for large scale problems. In this talk, we first review the basic principles behind interpolatory methods and discuss how to construct (locally) optimal reduced models at modest cost using Iterative Rational Krylov Algorithm. In various application, the original dynamics have special structures (such as internal delays, port-Hamiltonian structure) that need to be preserved during reduction. We will show how interpolation theory can be applied so that the reduced model preserves the underlying structure. Also, we will discuss optimal interpolatory model reduction for bilinear systems, a special class of weakly nonlinear systems. For model reduction to be efficient in the case of general nonlinear systems, Discrete Emprical Interpolation Method (DEIM) is employed to approximate the reduced nonlinear term. We will introduce a new framework for the DEIM projection operator that has a sharper error bound for the DEIM projection error and is independent of unitary basis transformations.