ORDER REDUCTION OF TRULY LARGE-SCALE LINEAR DYNAMICAL SYSTEMS

Roland W. Freund
Department of Mathematics, University of California at Davis, One Shields Avenue, Davis, CA 95616 U.S.A.,
e-mail: freund@math.ucdavis.edu

Keywords: dimension reduction, order reduction, Krylov subspace method, Padé approximation, Padé-type approximation, projection

Abstract

In recent years, Krylov subspace methods have become widely-used tools for order reduction of large-scale linear dynamical systems; see [1] for a recent survey of such reduction techniques. Despite all the progress in this area, the development of algorithms that are applicable to truly large-scale systems and at the same time preserve the key structures of the large-scale system remains a challenging task. For example, state-of-the-art algorithms, such as SPRIM [2], for structure-preserving order reduction of the large-scale systems arising in VLSI circuit simulation are based on explicit projection. They first generate a basis matrix of the underlying Krylov subspace and then employ projection using some suitable partitioning of the basis matrix to obtain a structure-preserving reduced-order model. There are two major problems with the use of such explicit projections. First, it requires the storage of the basis matrix, which becomes prohibitive in the case of truly large-scale linear dynamical systems. Second, the approximation properties of the resulting structure-preserving reduced-order models are far from optimal, and they show that the available degrees of freedom are not fully used.

In this talk, we first present an overview of Krylov subspace-based reduction techniques for large-scale linear dynamical systems. We then discuss some recent variants of these techniques that avoid explicit projection and are thus applicable to truly large-scale systems.

Acknowledgement: This research was supported in part by the National Science Foundation grant DMS-0613032.

References

[1] R. W. Freund, *Model reduction methods based on Krylov subspaces.* Acta Numerica, 12 (2003), pp. 267–319.

[2] R. W. Freund, *SPRIM: structure-preserving reduced-order interconnect macromodeling,* In m Tech. Dig. 2004 IEEE/ACM International Conference on Computer-Aided Design, Los Alamitos, California, IEEE Computer Society Press, (2004), pp. 80–87.