Model reduction of large–scale systems

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Abstract. In many applications one is faced with the task of simulating or controlling complex dynamical systems. Such applications include for instance, weather prediction, air quality management, VLSI chip design, biological systems, MEMS (micro electro–mechanical systems) etc. In all these cases complexity manifests itself as the number of first order differential equations which arise. For the above examples, depending on the level of modeling detail required, complexity may range anywhere from a few hundred to a few million first order equations. Simulating (controlling) systems of such complexity becomes a challenging problem, irrespective of the computational resources available. In this talk after presenting some motivating examples, we will define the model reduction problem in mathematical terms. Subsequently, the prevailing methodologies for its solution will be sketched; they all involve projections and fall into three broad categories. (I) SVD–based methods, which are well known in the systems and control community, and have good system theoretic properties. (II) Krylov–based methods, which are well known in the numerical analysis community and to a lesser degree to the system theory community, and have good numerical properties. (III) SVD–Krylov based methods, which seek to develop methods which combine the best attributes of (I) and (II). Furthermore, the class of weighted SVD methods, establish a link between (I) and (II). The talk will conclude with some new results, open problems and directions for future research.

Reference: A.C. Antoulas, *Model reduction of large–scale systems*, SIAM, Philadelphia (2004).