Gramian Based Model Reduction of Large-Scale Systems

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We describe model reduction techniques for large scale dynamical systems, modeled via systems of equations of the type

$$\left\{ \begin{array}{l} F(\dot{x}(t), x(t), u(t)) = 0 \\ y(t) = H(x(t), u(t)), \end{array} \right.$$

as encountered in the study of control systems with input $u(t) \in \Re^m$, state $x(t) \in \Re^N$ and output $y(t) \in \Re^p$. These models arise from the discretization of continuum problem and correspond to sparse systems of equations $F(. , . , .)$ and $H(. , .)$. The state dimension N is typically very large, while m and p are usually reasonably small. Although the numerical simulation of such systems may still be viable for large state dimensions N, most control problems of such systems are of such high complexity that they require model reduction techniques, i.e. techniques that construct a lower order model via a projection on a state space of lower dimension. We survey such techniques and put emphasis on the case where $F(. , . , .)$ and $H(. , .)$ are linear time-invariant or linear time-varying.